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WAR MACHINE

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Armed Forces of the World: British Army (Part 2)

Guided Bombs in Action

Daring the Dragon's Jaw

Area Denial Weapons

Modern Free-Fall Bombs

A fully illustrated guide to Modern Air-to-Ground Weaponry

WAR MACHINE

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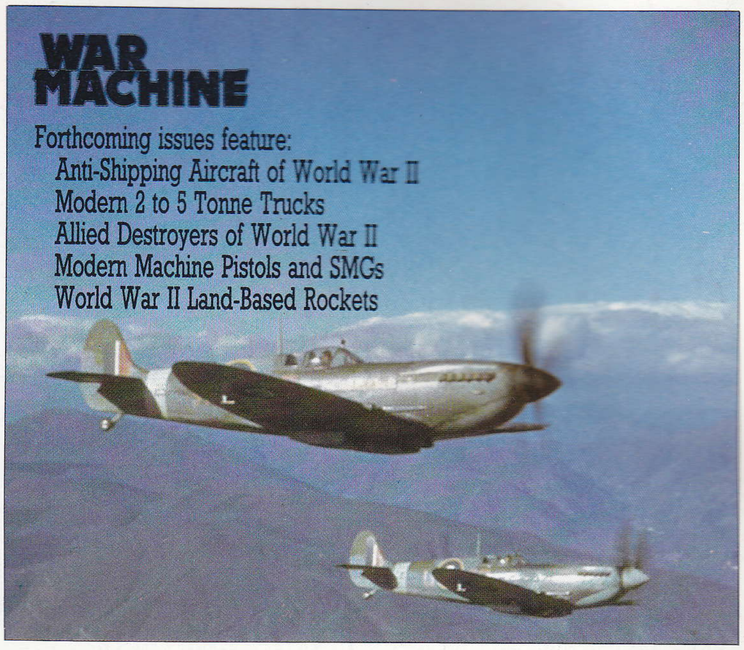

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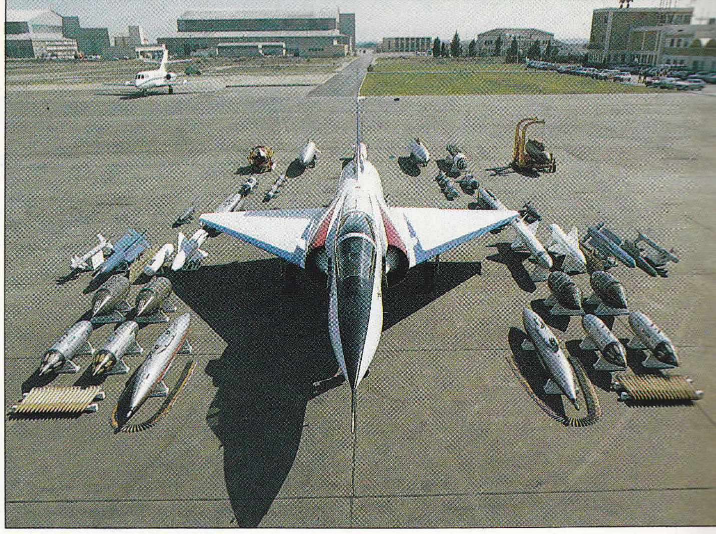
Modern Air to-Ground Weaponry



Typical of modern combat aircraft, the Dassault Mirage 2000 is capable of carrying a wide range of weapons, including bombs, cluster bombs, unguided rockets and air-to-surface and air-to-air missiles.

By far the largest proportion of the strength of modern air forces is dedicated to what American planners have called the 'Air-Land Battle', providing assistance to allied ground forces and interdicting the enemy. To be effective, air arms have to be able accurately to deliver sophisticated weaponry.

Air-to-surface weaponry encompasses a wide variety of types ranging from the simple, relatively inaccurate mass-produced cheap 'iron' bomb, through unguided air-to-surface rockets to the highly sophisticated, very accurate and extremely expensive precision-guided munitions such as the air-to-surface missile and the guided bomb. It also includes such weapons as the various types of cluster bombs designed to carry large numbers of small bomblets or mines for use against area targets, and the new dispenser weapons to be carried under the fuselage of the Panavia Tornado strike aircraft.

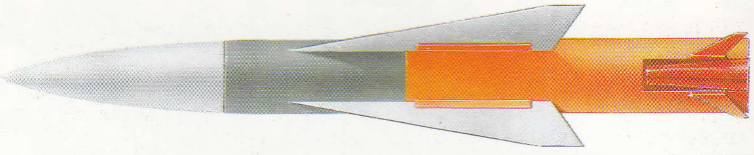
In assessing the capabilities of the world's air forces and their inventories of these weapons, it rapidly becomes apparent that only relatively few nations have available the complete spectrum of air-to-surface weapons, and that even some of the larger nations, such as Communist China, seem to be fairly backward in the types they have have in service. Both the USA and the USSR are very well equipped, whilst the Royal Air Force is poorly equipped, the more so when one considers that a weapon such as a cluster bomb is fairly cheap to design and build, or even to buy 'off the shelf' from another nation. Moreover, an increasing number of modern precision-guided weapons with stand-off capability are needed today just to reduce the anticipated losses of strike aircraft committed against such sophisticated air defences as the Soviets currently have available. If the present Ministry of Defence planning in this field for the Royal Air Force remains unaltered, the service will not be able to meet all its conventional NATO target commitments and would almost certainly lose significant numbers of its aircraft during overflights to deliver fairly outmoded weapons. The Falklands war was a severe lesson in this respect, as all the BAe Harrier and Sea Harrier combat losses were to Argentine air defences that are minimal in comparison with those that must be anticipated in attacks on a Warsaw Pact airfield, or even a target just behind the main battle zone.

Israel has vast combat experience derived from her Middle East wars and has realized that a wide variety of weaponry is required to meet the requirements of specific occasions, especially as she considers that the lives and experience of her pilots are of paramount importance.

An American Boeing B-52H is seen dispensing retarded bombs at low level. Such flying is essential in the face of modern air defences, and the weaponry must be slowed to enable the aircraft to escape the blast.

FRANCE

Aérospatiale AS.30 and AS.30 Laser



The AS.30 has been operational for nearly 25 years, and in that time has seen a continual enhancement of its capability. With its Mach 1.5 speed, the AS.30 has a range of some 11.25 km (7 miles).

An AS.30 Laser is seen mounted on a SEPECAT Jaguar during the first homing trials for the system. With laser guidance the latest AS.30 is accurate to within 2 m (6 ft 6 in), as compared to the earlier version's accuracy of 10 m (32 ft 9 in).

Essentially a scaled up AS.20, the **Aérospatiale AS.30** started life in 1958 as the **Nord 5401**. In 1960 the basic AS.30 was fielded aboard the Dassault Mirage III fighter-bomber to meet a French air force requirement for an air-to-surface missile (ASM) that could be launched without the carrier coming within 3 km (1.86 miles) of the target. With a range of over 10 km (6.2 miles) and a terminal CEP of less than 10 m (32.8 ft), the original version required the operator to keep the missile aligned on the target with a joystick and tracking flares on the rear of the missile's body; a radio link was used to transmit corrective guidance commands to the onboard autopilot for course corrections. In 1964 an improved variant with a TCA semi-automatic guidance system and new flip-out fins entered production and service only for the French air force. This **AS.30 TCA** employs a SAT tracker unit for the continuous monitoring of an IR flare on the missile's rear, the pilot having only to keep the target centred in his attack sight. Over 3,870 AS.30s were built for a number of nations, operators being France, India, Israel (now out of service), Peru, South Africa, Switzerland, UK (now out of service) and West Germany. Of these South Africa has used the missile under operational conditions to attack and damage the abandoned and drifting oil tanker *Wafra* off her coastline, the launch aircraft in this case being the BAe Buccaneer S.Mk 50.

To enhance the weapon's capabilities into the 1990s, Thomson-CSF and Aérospatiale began work in 1974 on a laser-guided version. The target designation pod is the Automatic Tracking Laser Illuminator System (or Atlis), whilst the laser seeker head is called Ariel. By 1980 the first homing trials with pre-production rounds were under way, and in late 1983 the first deliveries of production **AS.30 Laser** rounds were made to the French air force for use on its SEPECAT Jaguar fighter-bombers, and several other as yet unidentified countries have since adopted the type.

Specification

AS.30 series

Type: air-to-surface missile

Dimensions: length (AS.30) 3.839 or 3.885 m (12 ft 7.1 in or 12 ft 9 in), or (AS.30 Laser) 3.65 m (11 ft 11.7 in); span 1.0 m (3 ft 3.4 in); diameter 0.34 m (13.4 in)

Launch weight: 520 kg (1,146.4 lb)

Propulsion: solid-propellant rocket motor

Performance: speed Mach 1.5; range 11.25 km (7 miles); CEP (AS.30 and AS.30 TCA) less than 10 m (32.8 ft) or (AS.30 Laser) about 2.0 m (6.6 ft)

Guidance: AS.30 manual, AS.30 TCA semi-automatic to line-of-sight, and AS.30 Laser laser-homing

Warhead: 240-kg (529-lb) HE with impact or delay-action fusing

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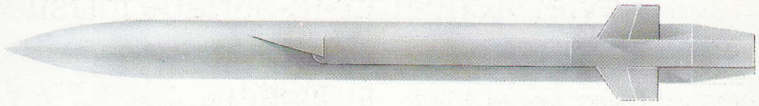
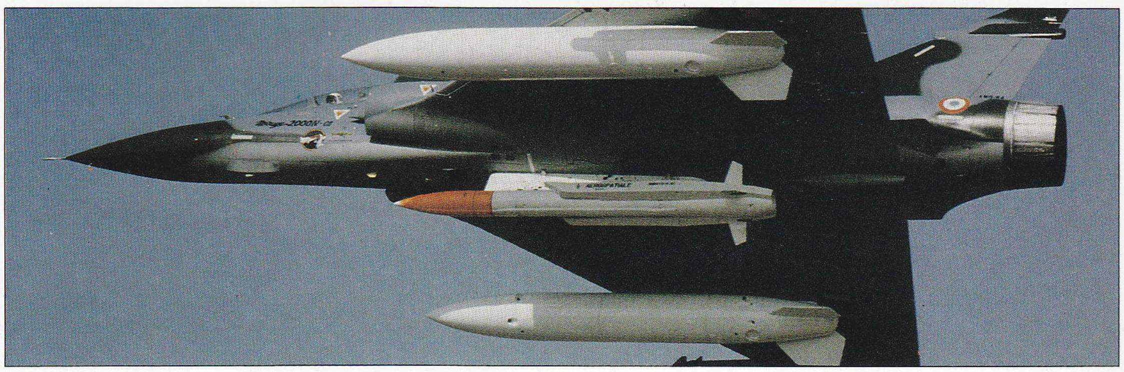
FRANCE

Aérospatiale ASMP



Right: The large ASMP (medium-range air-to-surface missile) weighs 1000 kg (2,205 lb) at launch and can travel at speeds of up to Mach 4.



Scheduled to replace most free-fall nuclear bombs in French service, the ASMP missile will be mainly delivered by the strike version of the Dassault Mirage 2000, and by remaining Mirage IV bombers. Super Etendards will also be fitted to operate ASMP.

The **Aérospatiale ASMP** (Air-Sol Moyenne Portée, or medium-range air-to-surface missile) is due to become France's main air-delivered nuclear weapon. It is powered by a liquid-fuel ramjet system and will be used mainly against tactical targets such as road and railway bridges, transport depots, and command, control and communications facilities. It will also have a semi-strategic role against hardened targets, and for this a total of 16 Dassault-Breguet Mirage IVA bombers of the Force de Frappe are being converted to the Mirage IVP configuration to carry one round under the fuselage in place of the current AN22 60/70-kiloton yield free-fall nuclear bomb. The first of two squadrons to operate the Mirage IVP will commission in 1987.

For the tactical role with the ASMP the French air force is procuring 85 Dassault-Breguet Mirage 2000N two-seat low-altitude strike fighters, which from 1988 onwards will initially supplement and then replace the SEPECAT Jaguars at present assigned to this mission with single AN52 15-kiloton yield free-fall bombs. The French navy is also converting approximately 50 of its carrier based Dassault-Breguet Super Etendard fighters as launch platforms.

Missile guidance is of the preprogrammed inertial type with several flight profiles available. In general terms these profiles are believed to be similar to those available to the American AGM-69 SRAM. A total of 100 operational rounds is to be procured for the two services, and these will replace the majority of the free-fall nuclear bombs now held in stock.

Specification

ASMP

Type: tactical and/or semi-strategic air-to-surface missile

Dimensions: length 5.38 m (17 ft 7.8 in); span not known; diameter 0.96 m (3 ft 1.8 in)

Launch weight: 1000 kg (2,205 lb)

Propulsion: liquid-fuel ramjet

Performance: speed Mach 4; range 300 km (186 miles); CEP not known

Guidance: inertial

Warhead: 150-kiloton yield nuclear

SWEDEN

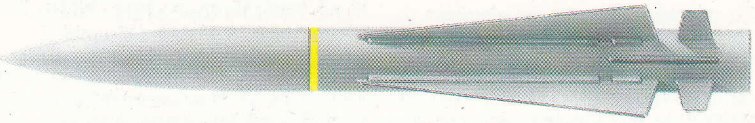
Saab-Bofors Rb05A

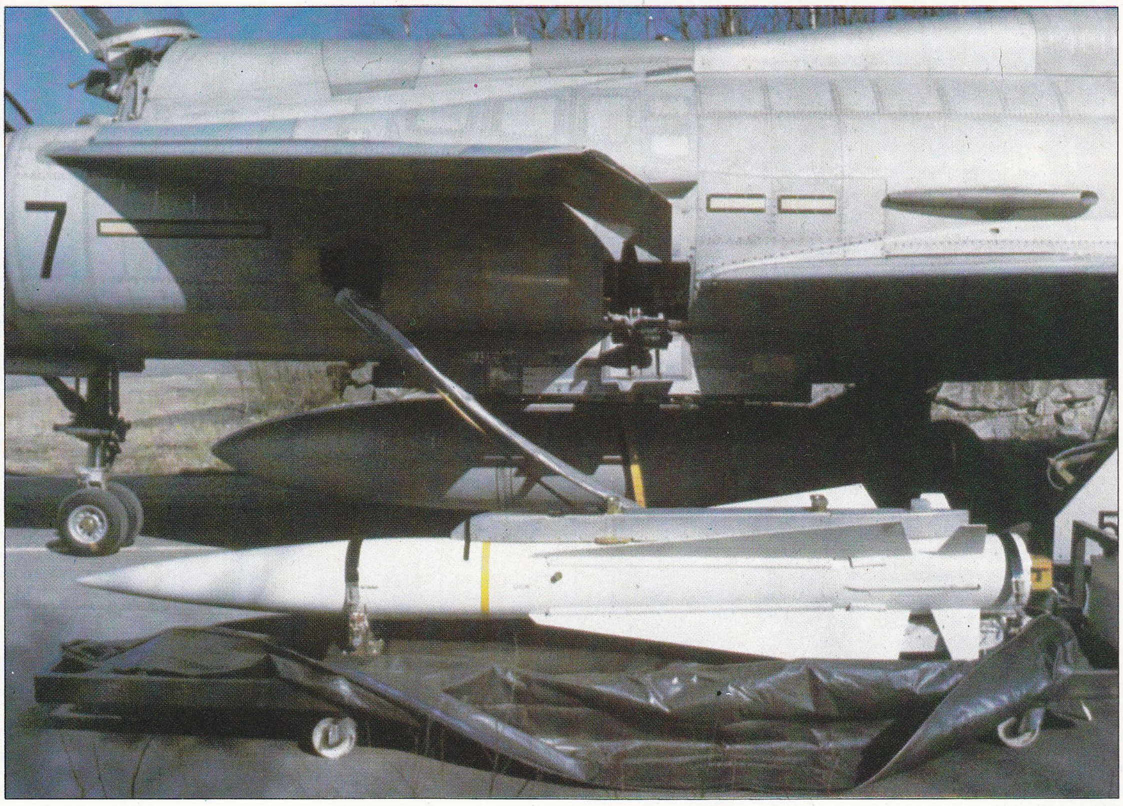
The **Saab-Bofors Rb05A** is a simple, manually-controlled radio-command weapon for carriage on a wide variety of launch platforms. It is intended mainly for use against land and sea targets, but it may also in certain circumstances be used in an air-to-air role against such targets as a hovering helicopter. The airframe consists of a pointed cylindrical body with long-chord cruciform wings and aft-mounted cruciform control surfaces. A liquid-propellant rocket motor is centrally located, and the electrical preheating of the round is undertaken by the carrier platform.

Once the missile has been launched from a height of 20-50 m (65-165 ft), the aircraft climbs to around 300-400 m (985-1,310 ft) and the pilot manually guides the weapon by lining it up on the target with the visual aid of rear-mounted tracking flares. Any control signals required are passed to the Rb05A via the radio link to the missile's onboard receiver. Once the missile is in the target's vicinity, a proximity fuse detonates the HE blast-fragmentation warhead.

The Rb05A is used by the Swedish air force's Saab AJ37 Viggen attack and Saab 105 light strike and trainer aircraft. Production started in the early 1970s and ceased in 1977. A more sophisticated version, the **Rb05B** with electro-optical TV homing, was to have been built, but this was cancelled when the Swedes bought the Hughes AGM-65A Maverick in its place.

Right: Armed with an HE blast fragmentation warhead, the Mach 1+ Rb05A missile may be used in a limited air-to-air role as well as in its primary function as a tactical air-to-ground weapon.





Arming the Saab AJ37 attack aircraft, the Rb05A is a relatively simple missile, steered manually by radio command. The pilot of the aircraft tracks the missile visually after release, guidance being made easier by flares in the missile tail. The warhead has a proximity fuse.

Specification
Rb05A
Type: air-to-surface missile
Dimensions: length 3.60 m (11 ft 9.7 in); span 0.80 m (2 ft 7.5 in); diameter 0.30 m (11.8 in)
Launch weight: 305 kg (672.4 lb)
Propulsion: liquid-propellant rocket
Performance: speed Mach 1+; range 9 km (5.6 miles); CEP less than 10 m (32.8 ft)
Guidance: manual radio command
Warhead: HE blast fragmentation

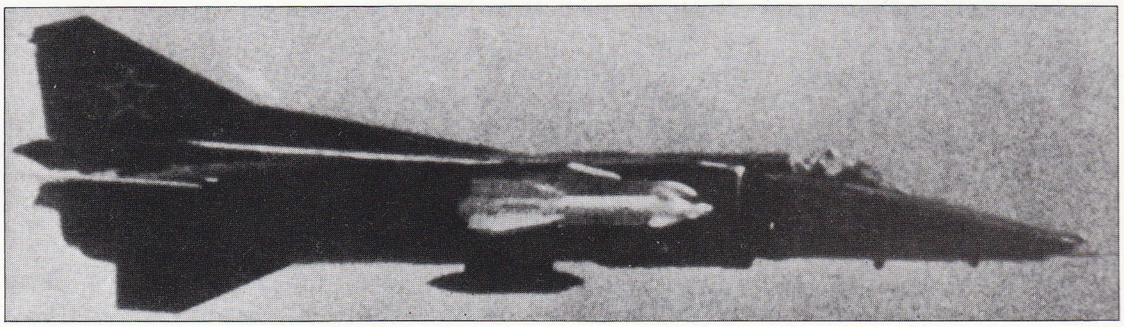
USSR

Soviet tactical air-to-surface missiles

It is notoriously difficult to obtain any reliable data on Soviet weapons of any description unless they have been captured. However, in the area of tactical air-to-ground weapons it is known that the Soviets have paralleled many of the Western equipment types, and in some specific areas such as fuel-air explosive munitions have gained a real lead in development.

The early Soviet tactical ASMs never received NATO reporting names, but from American sources it has been discovered that they were physically based on air-to-air missiles. The first real ASM to be seen by NATO was given the designation **AS-7 'Kerry'**. This entered service in the late 1970s with both the Soviet air force and navy, and is a single-stage radar beam-riding solid-propellant missile equivalent to the much earlier American Bullpup series. This was followed by the **AS-8**, which is a fire-and-forget anti-tank weapon for the Soviet attack helicopters such as the Mil Mi-24 'Hind', and perhaps the Sukhoi Su-25 'Frogfoot' battlefield support aircraft. The **AS-9** was the next in the sequence, and this is reported to be a comparatively large turbojet-powered supersonic anti-radiation missile (ARM) with a range of 100 km (62 miles) and a warhead of 150 kg (331 lb) for use by bombers and strike aircraft in penetrating air defences. The more recent **AS-11** and **AS-12** are said to be improved versions of this missile with different homing heads and increased performance. The intervening weapon, the **AS-10**, is a Mach-1 solid-propellant missile with electro-optical homing, a range of 11.1 km (6.9 miles) and a 100-kg (220-lb) warhead. The last missile for which details are available is the **AS-14** (formerly known to NATO as the **Advanced Tactical ASM**). This is a larger version of the AS-10 with mid-course guidance and the electro-optical homing system used for the terminal phase of its maximum 40-km (25-mile) flight trajectory. Recent photographic evidence has shown it under the wings of a Mikoyan-Gurevich MiG-27 'Flogger-J' fighter-bomber.

The Soviets also have laser-guided versions of their standard FAB-500, FAB-750 and FAB-1000 GP low-drag iron bombs, together with versions of the 210-mm (8.27-in) S-21 and 325-mm (12.8-in) S-32 air-to-surface unguided rockets that have been fitted with limited visual-guidance systems. These supplement the vast array of conventional weapon types deployed by the Soviets.



The AS-14 is one of the most advanced tactical missiles in service with the Soviets for which any information is available in the west. Carried by the MiG-27 'Flogger-J', it is thought to have an electro-optical guidance system with mid-course correction.

Specification
AS-7 'Kerry'
Type: air-to-surface missile
Dimensions: not known
Launch weight: 1200 kg (2,646 lb)
Propulsion: solid-propellant rocket motor
Performance: speed Mach 1; range 11.1 km (6.9 miles); CEP not known
Guidance: radar beam-riding
Warhead: 100-kg (220.5-lb) HE blast fragmentation

USSR

Soviet strategic air-to-surface missiles

At present the strategic elements of the air armies of the Soviet Union use strategic variants of the **AS-3 'Kangaroo'**, **AS-4 'Kitchen'** and **AS-6 'Kingfish'** ASSMs. The Soviets also use versions of the last two missiles with passive radar-homing systems to destroy radars assessed as being of prime importance in the defence of targets likely to be attacked by Soviet strategic bombers.

Of the three listed systems only the AS-3 was developed solely for the strategic mission, the others also being available in anti-shipping variants for use by the Soviet naval air force. The 'Kangaroo' was based on an aircraft airframe with turbojet propulsion. The guidance is handled by an autopilot with mid-course command-correction facilities; no terminal homing system is fitted, and this lack of terminal accuracy dictates the use of an 800-kiloton yield thermonuclear warhead. The range is 650 km (404 miles) using a high-altitude supersonic flight profile before a terminal dive at the target location. Carried only by the Tupolev Tu-95 'Bear-B' and 'Bear-C' four-engine long-range bombers, the AS-3 is gradually being replaced by the AS-4 (carried by the 'Bear-G' conversion) and by the **AS-X-15**. This latter is carried by the new-production 'Bear-H', which can launch a number of the low-altitude AS-X-15 cruise missiles, which each have a range of 3000 km (1,865 miles) and a 200-kiloton yield warhead.

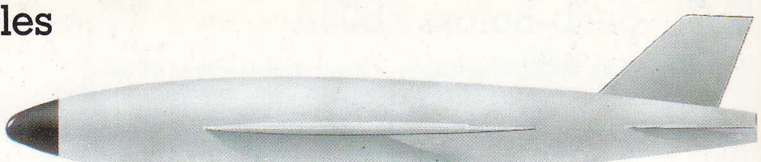
Both the Mach-3.5 AS-4 and the Mach-3.0 AS-6 are single-stage solid-propellant missiles. The AS-4 is inertially guided to its target, whereas the AS-6 has an autopilot guidance system. In the normal high-altitude flight profile the AS-4 has a range of 460 km (286 miles) and the AS-6 of 560 km (348 miles) with very steep terminal dives. In both case the missiles can be used on a low-altitude profile, which reduces their ranges to 300 km (186 miles) and 250 km (155 miles) respectively. The nuclear warhead carried by both is of 350-kiloton yield, although this may be exchanged for a 1000-kg (2,205-lb) HE warhead if required.

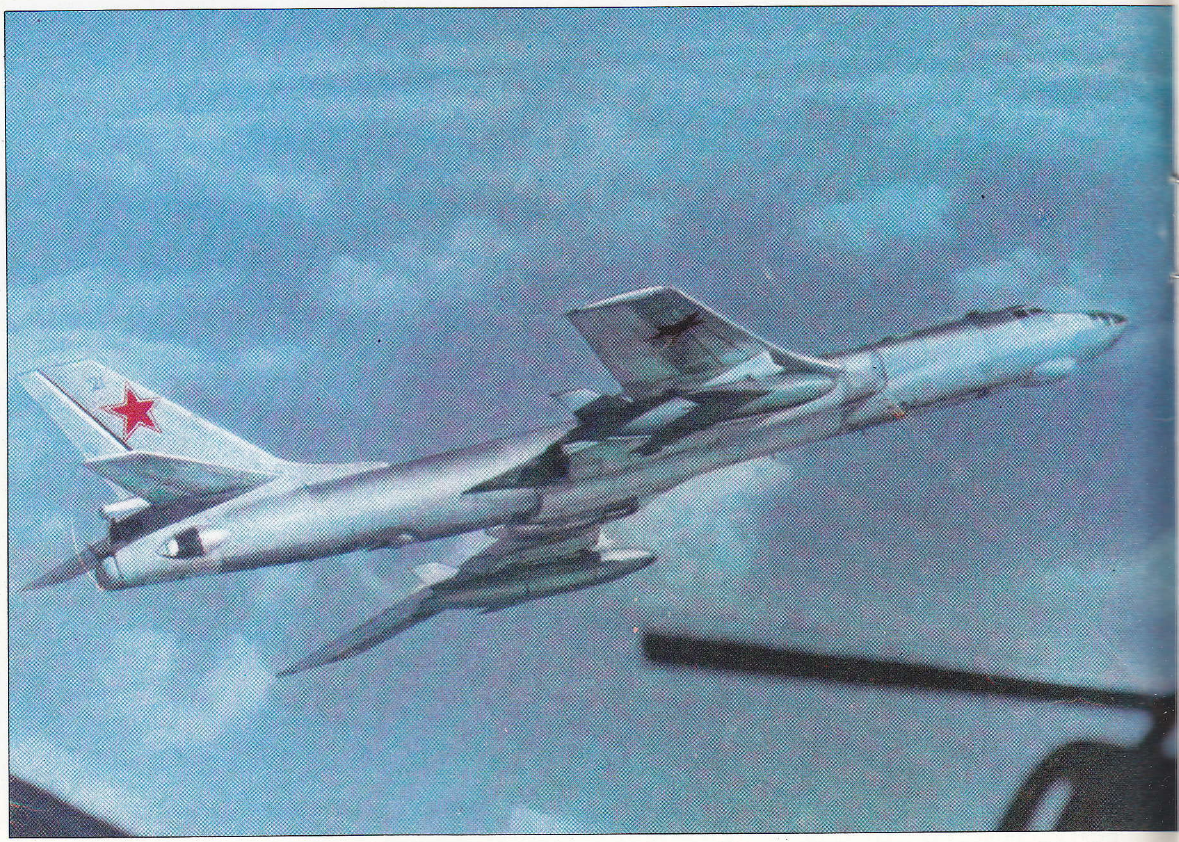
The strategic forces also use the **AS-5 'Kelt'** on occasion with their medium bomber units. Thought to be used in this context with a passive radar-homing seeker for defence-suppression tasks, the 'Kelt' carries only a conventional 1000-kg (2,205-lb) HE warhead. It is a Mach-1.2 liquid-propellant rocket-powered winged missile with high- and low-altitude flight profile ranges of 230 km (143 miles) and 180 km (112 miles) respectively. According to Israeli sources, the terminal dive angle is very shallow and the weapon can easily be engaged by air-defence systems.

Further strategic air-launched strategic missiles of higher performance are known to be in development. Of the current weapons the USSR uses all, while the conventionally-armed AS-4 is used by Iraq, and the AS-5 by Egypt and Iraq.

Specification
AS-3 'Kangaroo'
Type: air-to-surface strategic missile
Dimensions: length 14.90 m (48 ft 10.6 in); span 9.14 m (30 ft 0 in); diameter 1.85 m (6 ft 0.8 in)
Launch weight: 11000 kg (24,250 lb)
Propulsion: one turbojet
Performance: speed Mach 1.8; range 650 km (404 miles); CEP not known
Guidance: autopilot with mid-course correction
Warhead: 2300-kg (5,071-lb) nuclear with a yield of 800 kilotons

Right: The AS-5 'Kelt' bears a family resemblance to the AS-1 'Kennel', with the major change being from jet to rocket power. In place of the jet intake, the AS-5 has the nose (and probably guidance system) of the 'Styx' shipborne SSM.





Above: Carried in pairs by the Tupolev Tu-16 'Badger', the AS-5 has been supplied to various Soviet clients operating the aircraft. The 8.59 m (28 ft 2 in) missile has a 1000-kg (2,205-lb) high explosive warhead.

Below: Most potent aircraft in the Soviet inventory, the Tupolev Tu-22M 'Backfire' is mainly armed with the supersonic AS-4 'Kitchen' both for the strategic and the anti-shipping roles.

Modern Free-Fall Bombs

The startling development of precision guided missiles since the end of World War II might have led many to suppose that the day of the old fashioned 'iron bomb' was done. That the truth is very different is a reflection of the multitude of different types of target confronting an attacking aircraft in modern warfare.

As most nations not in the Soviet bloc tend to use American-designed and American-built 'iron' bombs their development will be reviewed first.

In the immediate post-war period a proposal was received by the then Bureau of Aeronautics to revise the US Navy's existing bomb inventory to give a series of streamlined low-drag bombs that would be suitable for carriage by future generations of supersonic aircraft envisaged at the time. As the subsequent BuAer design concept was too long, the proposing company (Douglas) chose an Aero 1A shape with a length:diameter ratio of 8.3:1 and applied it to give the familiar Mk 80 series of general-purpose (GP) bombs, namely the 113.4-kg (250-lb) Mk 81, the 227-kg (500-lb) Mk 82, the 454-kg (1,000-lb) Mk 83 and the 907-kg (2,000-lb) Mk 84.

Meanwhile the US Air Force took its existing 340.2-kg (750-lb) bomb and modified it with a new streamlined tail to give the M117 Demolition Bomb. During the same period the Air Force produced the similar 1360.8-kg (3,000-lb) M118. These two bombs had thinner casings than the US Navy models and thus produced their effects by blast rather than fragmentation.

In the late 1950s and as part of the development of weapons for use in the periodic 'brushfire' wars in the world, the US Naval Weapons Center at China Lake began development of a series of unguided conventional weapons that had 'eye' series codenames. One of these was the Snakeye fin retarder for Mk 81 and Mk 82 bombs; this permitted the bombs to be carried by aircraft at high speed and then dropped at very low altitudes without destroying the plane in the subsequent blast. It achieves this effect by deploying several air-brake surfaces to slow the bomb's downward motion to a significant degree. However, even after years of use with the US forces, the Snakeye system is considered to be unreliable. For the longer term an Advanced General-Purpose bomb is under study for use by the US Navy in three sizes: 226 kg (500 lb), 454 kg (1,000 lb) and 907 kg (2,000 lb). The smallest bomb size has been discarded as it is considered too light for a modern battlefield and its targets. The US Air Force may well use these bombs (as it did eventually the Mk 80 series) but instead seems to be veering towards the continued use of its old iron bombs (at least until current stocks are exhausted) but upgrading them into precision-guided munitions and supplementing them with new-build glide-bomb systems.

Although the Cluster Bomb Unit (CBU) munition was in service as early as World War II, the US Navy generally neglected its development during the first post-war decade. In sharp contrast the US Air Force moved into this field in a big way as it concluded that such weapons were particularly useful in enabling individual aircraft to make multiple kills of scattered targets on a single pass through intense ground fire. Thus the US Navy designed only a few of these weapons, of which the Mk 20 Rockeye II anti-armour cluster bomb is perhaps the most familiar as it has been used by Israel in combat during the 1973 'Yom Kippur' War and the 1982 invasion of Lebanon; the type entered service with the US Navy in 1968.

The US Air Force has assigned at least 92 CBU numbers to munitions, although not all of these have entered service. The latest conventional CBU with instantaneous effect submunitions to have entered production is the CBU-87/B Combined Effects Munition which contains 202 bomblets in a SUU-64/B dispenser. Each bomblet has a shaped charge, a fragmentation section and an incendiary device. A considerable number of the CBUs designed and built found use in the Vietnam War (such as the CBU-19A/B and CBU-30/A which used CS tear gas bomblets, and the CBU-52/B with fragmentation bomblets) in the air-defence suppression role by literally smothering a site with the bomblets.

In Europe the UK generally followed the US Air Force's lead after World War II by using slightly modified versions of its World War II

Perhaps the greatest change to have occurred in recent years has been the virtual disappearance of the bomb bay from tactical aircraft. Even the General Dynamics F-111, although having a small weapons bay, was designed to carry massive loads of ordnance on underwing hard points.

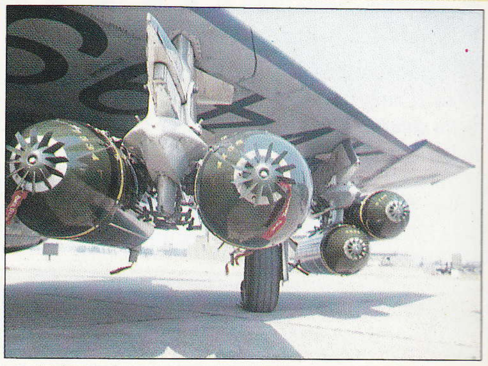
The external carriage of stores can produce significant aerodynamic drag, considerably degrading aircraft performance. The modern free-fall bomb is much more streamlined than its predecessors, assisting aircraft such as the Grumman A-6 Intruder.

The old-style heavy bomber still exists in the shape of the Boeing B-52. The massive bomb load, up to 24500 kg (54,000 lb), was used to devastating effect in the Vietnam War, enormous tonnages being dropped on the North.

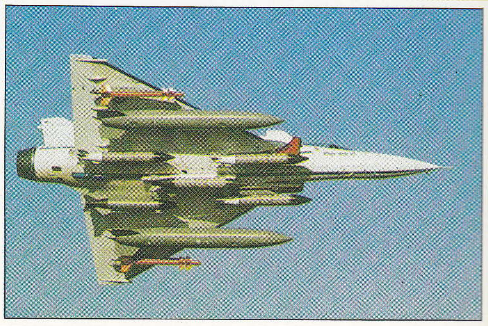
bomb stocks. The advent of fast jets required new weapons, however, resulting in the current 244.9-kg (540-lb) and 454-kg (1,000-lb) medium-capacity bombs which eventually gained tail retarding devices designed for the same function as the Snakeye. All these weapons are in widespread British use and have been exported, as is testified by the Argentine use of the 454-kg (1,000-lb) model against the Royal Navy during the 1982 Falklands war. However, unlike the Americans and their prodigious development of CBUs, British interest since the late 1960s has centred on only one weapon in this category, the BL-755 or Cluster Bomb Mk 1, which entered service with the Royal Air Force in the early 1970s as an anti-armour weapon. Used in the Falklands war as an area weapon against airfield facilities, troop concentrations and supply dumps, it proved relatively successful although a greater choice of submunition types would have been welcome. An improved version, with capability against the latest Soviet armour, is now being procured. In direct comparison with what is available to American forces and the air forces of some other nations, such as France and Israel, the Royal Air Force's current capabilities in the free-fall bomb field are at best questionable.

France, with its manufacturers Thomson-Brandt and Matra and their range of weapons from CBUs to cratering bombs, seems to have a better grasp than MoD planners of the munition types required for use in the modern battlefield. In fact it was Israel, with France's help, that developed and subsequently used the 'concrete-dibber' type of rocket-powered bombs: in the 1967 Six-Day War against the Egyptians the Israelis closed a number of the enemy's airfields by causing severe crater damage beneath the runway surface as a result of the bombs' tunnelling effects. The next use of such a weapon was during the 1971 Indo-Pakistan War, when bombs of a similar type with the Soviet designations BETAB-250 and BETAB-500 were dropped by Indian Air Force Mikoyan-Gurevich MiG-21s and Sukhoi Su-7s.

During the numerous conflicts that the Soviet client states have fought, and in the current Soviet operations in Afghanistan, a comprehensive array of free-fall bombs and cluster munitions has been used. The Soviets' latest narrow-body free-fall low-drag GP bombs are designated FAB-100, FAB-250, FAB-500, FAB-750 and FAB-1000 (the number indicating the weapon's notional weight in kilograms), and the Egyptians have revealed that the Soviets use tail-mounted retarding devices for the FAB-250 and FAB-500 models that are similar in design to the American Snakeye. Fragmentation versions of these two bombs also exist with the designations OFAB-250 and OFAB-500. There is also a series of incendiary bombs (but not napalm tanks) that corresponds in size to the FABs but allocated the prefix ZAB. Cluster munition designations are more difficult to discover, although it is known that ZAP-200, PTK-250, RPK-180, RPK-250 and RRAK all refer to such weapons. The cluster weapon has been extensively used in Afghanistan, especially with a parachute retarding device in order to achieve safe low-altitude delivery and dispensing. It is also known that various fuel-air explosive boosted napalm bombs are available, together with SOV-AB persistent toxic chemical agent and NOV-AB non-persistent toxic chemical agent bombs. The precise designations (and hence weights) of these weapons are not known.

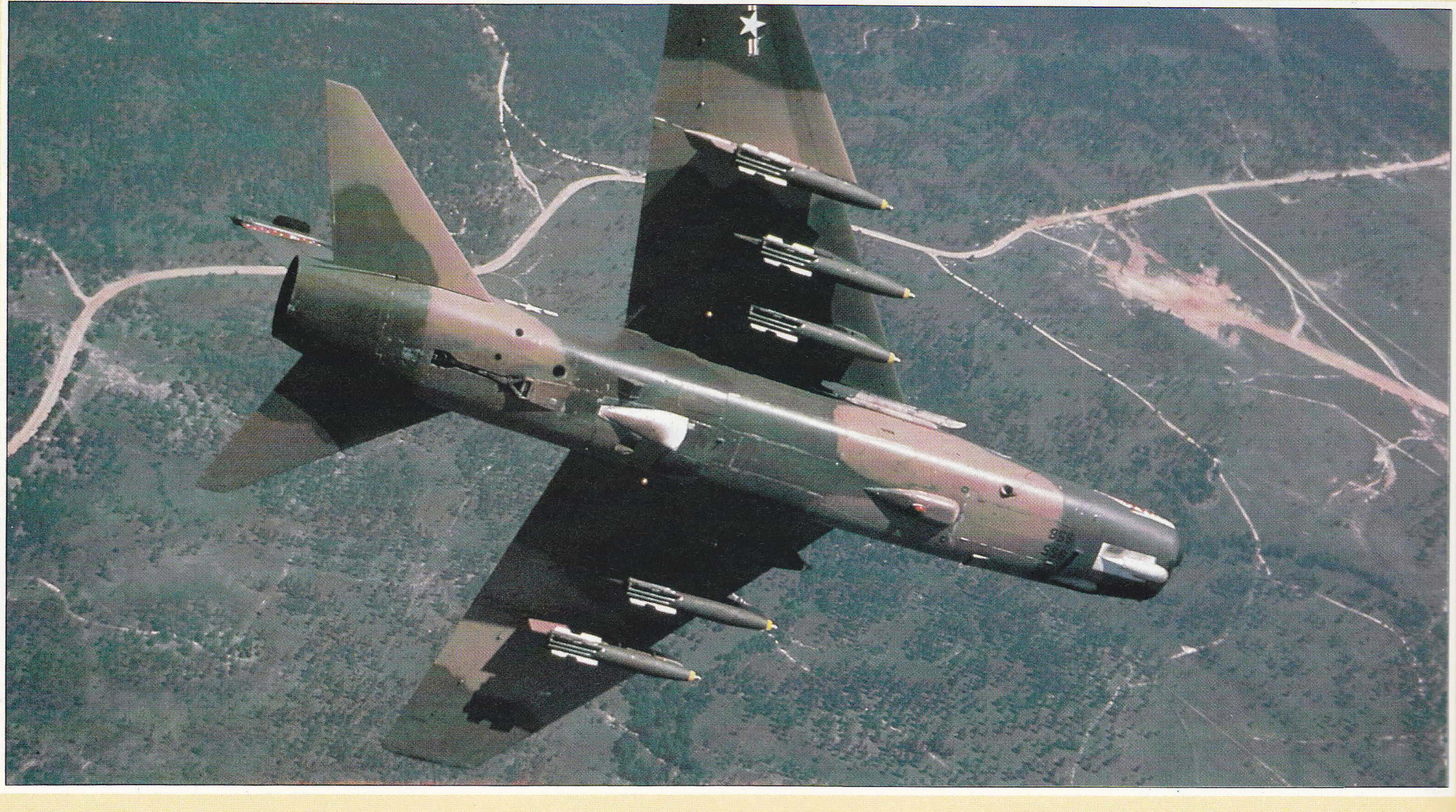


One of the most important types of bomb in the current inventory is the cluster bomb. Consisting of numerous sub-munitions in a single casing, the BL 755 was used extensively by Britain in the Falklands against soft and widely dispersed targets.



Above: The five Belouga BLG 66 dispensers carried by the Mirage 2000 each contain 151 grenades, with either fragmentation, armour-piercing or high-explosive (concussion) effects, depending upon the target to be attacked.

Below: An A-7 Corsair of the US Air National Guard displays its load of six 250-kg (550-lb) Snakeye Mk 82 bombs. These are streamlined to prevent drag while being carried, but are fitted with high-drag retarding devices on the tail, which deploy when dropped.



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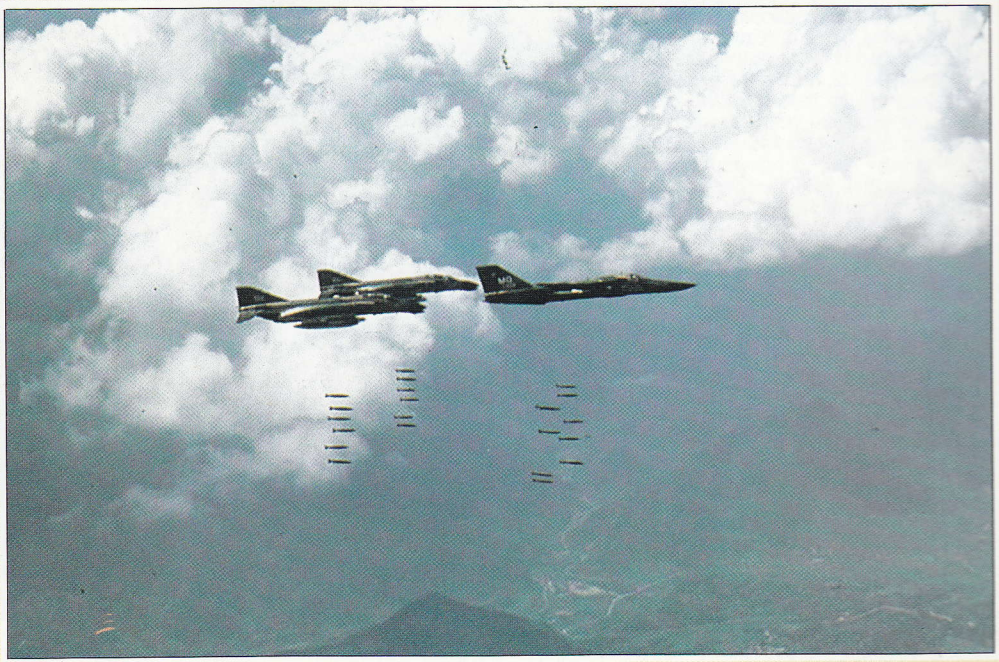
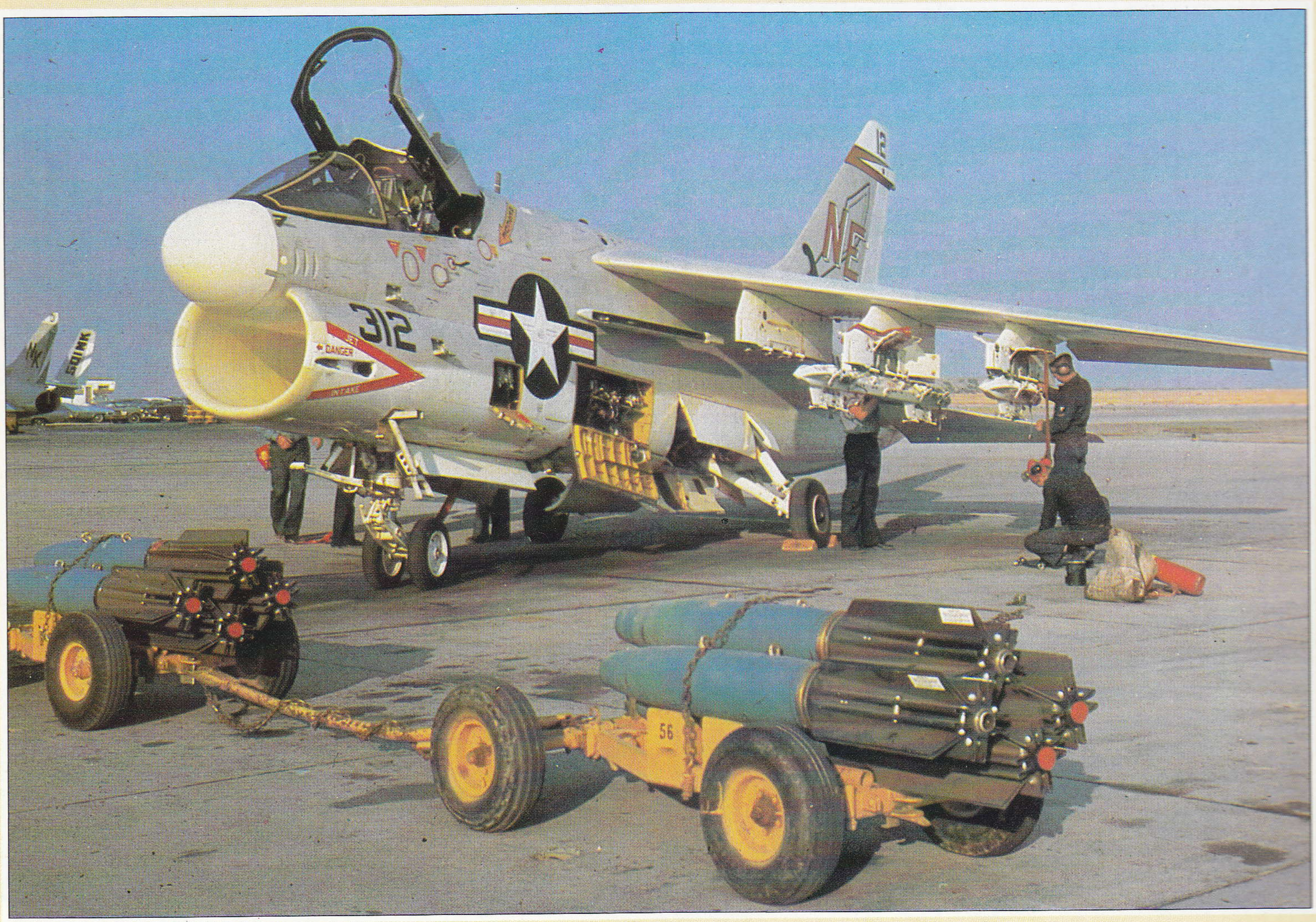


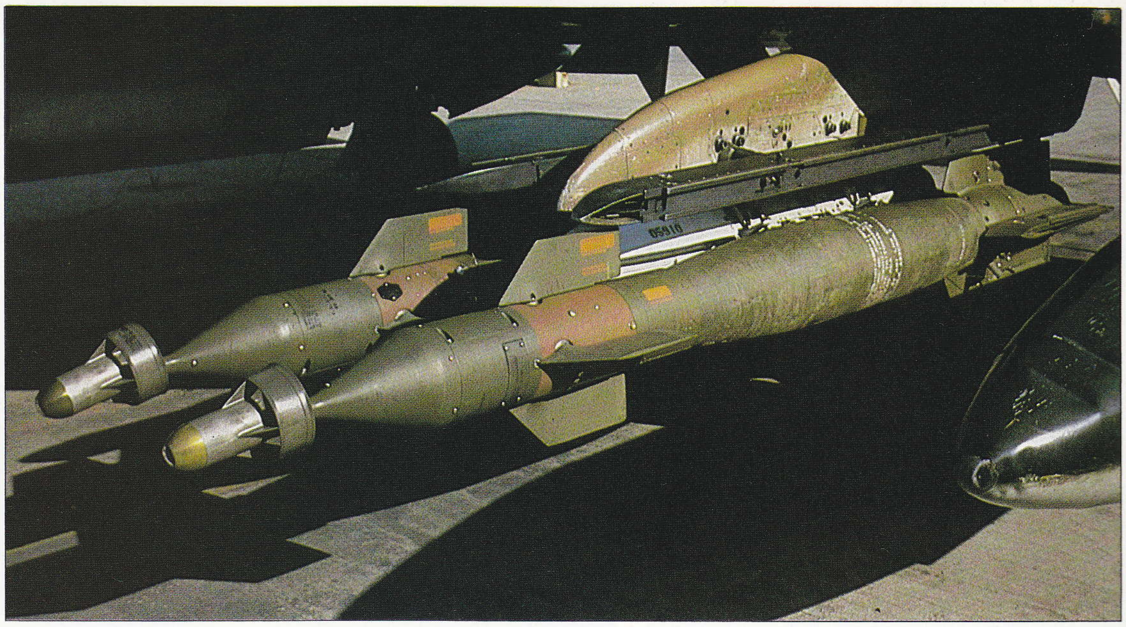
Above: When fitted to aircraft such as the Grumman A-6 Intruder, modern 225-kg (500-lb) or 450-kg (1,000-lb) GP (General Purpose) bombs are often mounted on triple ejector racks, sometimes with two racks to an underwing hard point.

Above: A technique much practiced in Vietnam was the use of lead ships equipped with blind or precision bombing equipment to lead formations of less well-equipped aircraft. The practice continues, with, typically, an F-111 giving release instructions to F-4s.

Below: A US Navy A-7 Corsair being bombed up illustrates both the triple ordnance ejector racks and the high drag tail attachments fitted to standard low drag bombs. On weapon release, the large fins deploy outwards, acting as airbrakes and slowing the bomb.



US guided bombs



Above: The use of precision guidance as applied to unpowered ordnance has led to the distinction between 'smart' weapons and 'iron' or unguided bombs. Paveway, guided by laser, is one of the oldest and most effective systems.

One of the major technologies developed for the Vietnam War was laser guidance for iron bombs. Although this was initially a US Air Force project, Texas Instruments helped in the development and ultimately produced the kits for the **Paveway** laser-guided bomb family. This programme has linked more than 30 different systems such as airborne navigation, target marking and identification, and all-weather and night-vision guidance into a single weapon type. The first laser-guided bomb was dropped in trials during 1965, and by 1971 the **Paveway I** family had grown to eight different guidance kits for addition to the nose and and tail of standard free-fall weapons. The guidance and control units were identical for all the kits but the sizes of the canard steering surfaces and tail assemblies varied according to the size of the bomb to be used. The nose-mounted laser seeker is mounted on a two-axis gimbal which has a ring located at its rear. After weapon release, air flowing over the ring causes the seeker to weathercock into the local airstream and hence point approximately towards the target's location. The target itself is illuminated by an airborne or ground-based laser designator, and the seeker on the bomb picks up the laser energy reflected from it, and via the onboard computer commands the control surfaces to guide the bomb towards the reflected energy's source.

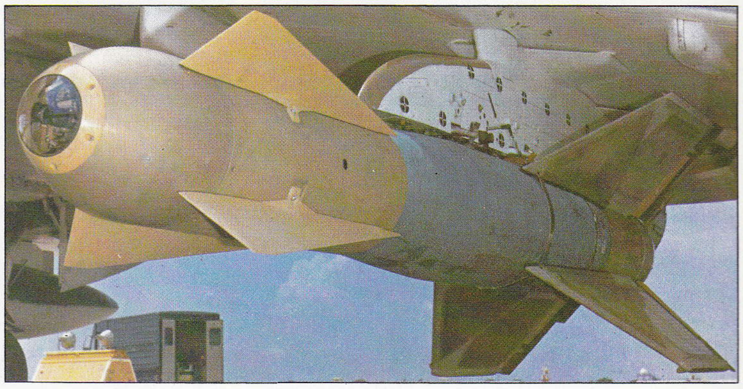
The Paveway I family consisted of the **KMU-342/B** kit for the M117 340-kg (750-lb) demolition bomb, the **KMU-351A/B** kit for high- and low-drag versions of the Mk 84 907 kg (2,000-lb) GP bomb, the **KMU-370B/B** for the 1361-kg (3,000-lb) M118E1 demolition bomb, the **KMU-388A/B** for the high- and low-drag versions of the Mk 82 227-kg (500-lb) GP bomb, the **KMU-420/B** for the US Navy's Rockeye Mk 20 Mod 2 227-kg (500-lb) cluster munition which carried 358 0.5-kg (1.1-lb) anti-tank fragmentation bomblets, and the **KMU421/B** for the US Air Force's Pave Storm I 907-kg (2,000-lb) cluster munition based on the SUU-54 dispenser carrying around 1,800 0.5-kg (1.1-lb) anti-tank fragmentation bomblets. The family was subsequently modified to exclude the KMU 342 and KMU 420 kits, whilst the KMU-421/B was switched to the US Navy's and US Marine Corps' Mk 83 454-kg (1,000-lb) GP bomb. Used extensively in the Vietnam War, the family is considered to be of the partial launch-and-leave weapon type as a designator is required, but this is more than offset by their night capability when used in conjunction with a designator fitted with a night sight; this capability extends to poor weather as long as the cloud base is not below 760 m (2,500 ft). The carrying aircraft requires no modification or electrical connection and the bombs are treated and loaded as normal rounds of ammunition.

In 1978 the **Paveway II** family was introduced into service with a new set of components and a folding wing aerofoil group which greatly improves manoeuvrability. The weapons in this series are the **GBU-12D/B** or **GBU-12F/B** (Mk 82 GP bomb), **GBU-16B/B** or **GBU-16C/B** (Mk 83 GP bomb), **GBU-10E/B** or **GBU-10F/B** (Mk 84 GP bomb) for the American services and the **Mk 13/18UK** (454-kg/1,000-lb Mk 13/18 GP bomb) for the Royal Air Force.

A third generation family, the **Paveway III**, designed specifically for launch at very low altitudes and significant stand-off ranges, has been developed and is to go into production shortly.

At the same time that the original Paveway programme was under way, Rockwell International was designing the **Homing Bomb System** (or **HOBOS**) for the US Air Force as a series of add-on modules to the larger standard bombs, but using initially an electro-optical TV image-contrast tracker and then improved TV and IR guidance seekers for use at night and in poor weather. The kit designations are the **KMU-353A/B** and **KMU-390/B** TV image-contrast systems and the **KMU-359/B** IR system. All three can be fitted to either the Mk 84 GP bomb or the M118E1 demolition bomb, and comprise a guidance section mounted over the bomb's nose, a control module with fins on its rear and four strakes along the body to connect the two assemblies.

To enhance the HOBOS series' capabilities yet further Rockwell looked at a Modular Glide Weapon System. This evolved into the **GBU-15**, which is now in service with the US forces and Israel. The GBU-15 uses a cruciform wing module, a control module, a data-link module, a guidance package and one of two warhead options. The actual configuration chosen depends on the type of target to be attacked, the specific weather conditions and whether the pilot wishes to attack the target directly or indirectly using the data-link pod. The guidance seeker can either be of the electro-optical TV type or of the imaging IR variety. The warhead is either the Mk 84 low-drag GP bomb or the SUU-54 dispenser with 1,800 BLU-63 and/or BLU-86 anti-tank fragmentation bomblets.



The GBU-15, unlike the Paveway system, makes use of an electro-optical guidance system, with either TV or infra-red seekers. At current aircraft attack speeds, release range is some 8 km (5 miles) even at low altitude. When the bomb is lobbed upwards, range is greater.

A powered version of the GBU-15, to be designated **AGM-130**, is currently under development by the firm. This will utilize a rocket booster to triple the maximum low-altitude release range to about 24 km (15 miles) to provide greater aircraft and crew survivability. A capability to carry and dispense boosted kinetic-energy penetrator submunitions is also to be incorporated.

The US Navy is to procure the **AGM-123A Skipper**, which is a Mk 83 bomb equipped with a Paveway II IR seeker and guidance and a Shrike ASM solid-propellant rocket motor. Like the AGM-130, the Skipper is to be used against heavily defended targets to improve the launch platform's safety.

Operators of the Paveway series are Australia, Canada, Greece, the Netherlands, Saudi Arabia, South Korea, Taiwan, Turkey, the UK, US Air Force, US Navy and US Marine Corps, plus others including (it is believed) Israel.

Specification

Paveway I (Mk 82 bomb with KMU-388A/B package)
Type: guided glide bomb
Launch weight: 272.2 kg (600 lb)
Performance: range between 1.5 and 18.3 km (0.93 and 11.4 miles) depending on launch altitude; CEP about 9.1 m (30 ft)
Warhead: HE blast fragmentation

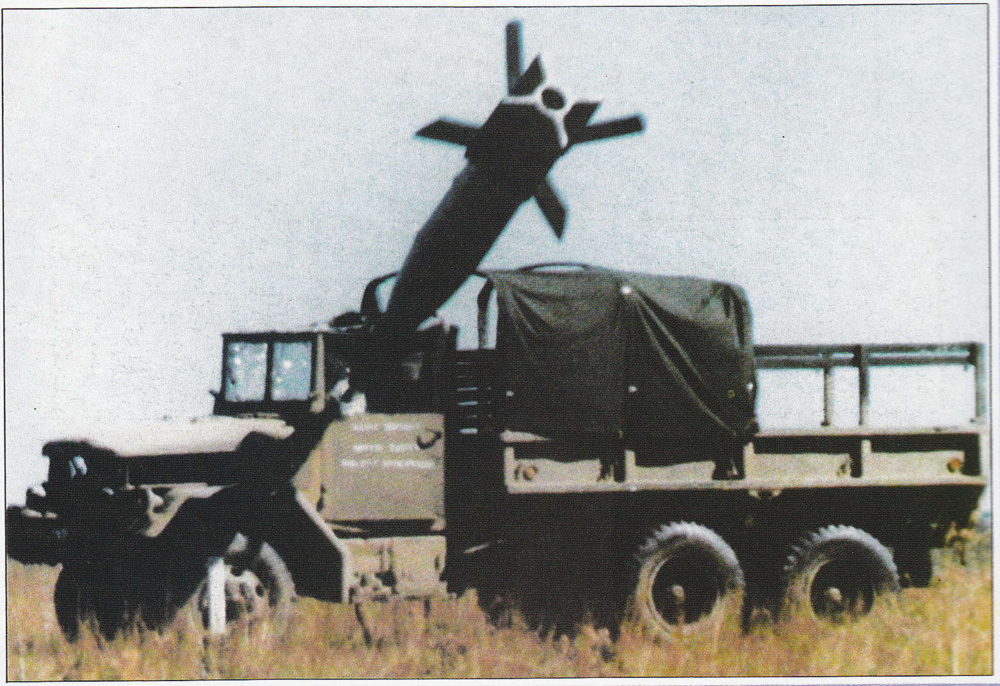
Paveway I (Mk 84 bomb with KMU-351A/B package)
Type: guided glide bomb
Launch weight: 952.6 kg (2,100 lb)
Performance: range between 1.5 and 18.3 km (0.93 and 11.4 miles) depending on launch altitude; CEP about 8.2 m (27 ft)
Warhead: HE blast fragmentation

HOBOS (Mk 84 bomb with KMU-353A/B package)
Type: guided glide bomb
Launch weight: 952.6 kg (2,100 lb)
Performance: range between 1.5 and 24.4 km (0.93 and 15.2 miles) depending on launch altitude; CEP about 6.1 m (20 ft)
Warhead: HE blast fragmentation

GBU-15
Type: guided glide bomb
Launch weight: 1111 kg (2,450 lb)
Performance: range between 1.5 and 82.3 km (0.93 and 51.1 miles) depending on launch altitude and whether or not a data-link pod is used; CEP less than 6.1 m (20 ft)
Warhead: HE blast fragmentation

Guided Bombs in Action

The tremendous technological advances of the 1950s and 1960s in the fields of electronics, computerization and lasers had an enormous effect upon warfare, with weapon guidance especially transformed.



The ability of lasers to pinpoint targets could not be better demonstrated than in the steering of a 900-kg (2,000-lb) bomb through the driver's window of a moving truck. With Paveway about, nobody can afford to relax.

The laser targetting can be carried out either from airborne pods, sometimes carried by the attacking aircraft, or by ground troops acting as forward observers with portable laser equipment.

The introduction of the Laser-Guided Bomb (LGB) into the US Air Force weapon inventory during 1968 for use in the Vietnam War brought a new dimension to warfare. It was the first time that the service had available a precision-guided munition (of sufficient weight and with night and poor weather capability) capable of destroying in single hits enemy targets that previously needed large numbers of aircraft with significant payloads of standard iron bombs. During the 'Commando Hunt VII' operations in the Steel Tiger area of Laos in late 1971 and early 1972, the LGBs proved of immense use in the second phase of the aerial interdiction programme, in which they were used at key points to cut roads along which North Vietnamese supply convoys of trucks used to travel. Once the roads were cut, the surrounding area was seeded with ground sensors and air-dropped land mines to form a 'blocking belt': when any of the sensors picked up sounds of the mines being cleared or the belt itself being bypassed, more strike aircraft were vectored in with LGBs or other munitions to attack the enemy force.

In March 1972, when the North Vietnamese regulars operating in support of the Pathet Lao moved against General Van Pao's Meo guerrilla headquarters at Long Thien south of the Plain of Jars, they used a number of the long range M-46 130-mm (5.12-in) artillery pieces to bombard the site. The US Air Force, flying air support for the Meos, found that the guns were difficult to spot and even more difficult to destroy with conventional munitions. Finally several LGBs were used to score direct hits.

The greatest test of the LGBs, especially the Mk 84 907-kg (2,000-lb) variant, came shortly afterwards during the North Vietnamese's Easter 1972 invasion of South Vietnam. This prompted the US government to order its air units to resume the bombing of North Vietnam. One particular target in that country which had been high on the target list since April 1966 (and which had been attacked on a number of occasions by both US Air Force and US Navy aircraft during the various bombing campaigns with hundreds of iron bombs, as well as Bullpup and Walleye guided weapons) was the heavily defended Thanh Hoa rail bridge. This target had cost the Americans a number of aircraft shot down together with aircrew killed, wounded or captured for a relatively poor return in damage inflicted on the structure. However, a single strike by the LGB-equipped McDonnell Douglas F-4 Phantoms of the 8th Tactical Fighter Wing flying from Ubon in Thailand destroyed the bridge, whose spans were dropped during the 6 April-30 June blitz on bridges that saw another 105 bridges also attacked.

Close support

Although extremely useful in such attacks on North Vietnam, the LGB also proved itself in South Vietnam in the tank-busting and close-support roles, where friendly troops had attackers within their positions. The 907-kg (2,000-lb) and 1361-kg (3,000-lb) weapons equipped with laser seekers and carried on such aircraft as the Phantom (supported by a forward air controller in a Rockwell OV-10 Bronco observation plane with a 'Pave Nail' laser designator) proved devastating to North Vietnamese tanks in the area north of Hue, where the open terrain afforded little concealment. On one occasion, for example, a FAC operating at twilight just north of the South Vietnamese marine positions on the My Chanh river line found two armoured vehicles near Route 1: a PT-76 light amphibious tank was trying to extricate a T-53 main battle tank from a dried-up stream bed. Air support was summoned and two Phantoms from Ubon arrived, one with a laser designator system and the other with LGBs. In the space of three minutes the tanks had been illuminated in turn by the designator-carrying aircraft and dispatched with single bombs from the other aircraft.

On 25 April at Fire Base 'Charlie', which had on the previous day been overrun by the North Vietnamese on the way to Kontum, FACs controlled a flight of the Ubon Phantoms to attack enemy troops and vehicles which were trying to take away undamaged South Vietnamese 105-mm (4.13-in) M101 howitzers. Only three Mk 84 LGBs were required to take out three of the guns and five of the trucks that were to be used to move them. Perhaps one of the most telling uses of the LGB occurred in May, after 'Pave Nail'-equipped Broncos arrived in the Highlands to help defend Kontum and its covering fire bases and camps. A Special Forces camp came under intensive North Vietnamese tank and infantry attack, and requested help from an FAC aircraft orbiting overhead; this FAC called up a 'Pave Nail' OV-10 and both arranged to get LGB-equipped F-4D Phantoms from Ubon. The ground contact in the meantime came on to the air and reported that a tank was trying to crush the camp's main command bunker and, overhearing the FAC's conversation, innocently asked what a 'Pave Nail' was. Both FACs told the Special Forces trooper to stand by and they would show him. The OV-10 then illuminated the tank in question with his laser designator and one of the F-4s, which had just arrived, rolled in and released a Mk 84 LGB. The 907-kg (2,000-lb) weapon impacted right beside the tank, the force of the explosion picking the tank up and blowing it back into the camp's perimeter wire. There was then a long silence from the trooper until his voice came on again and said 'What did you call that?' 'Pave Nail,' came the reply, to be answered by 'I need about two more.'

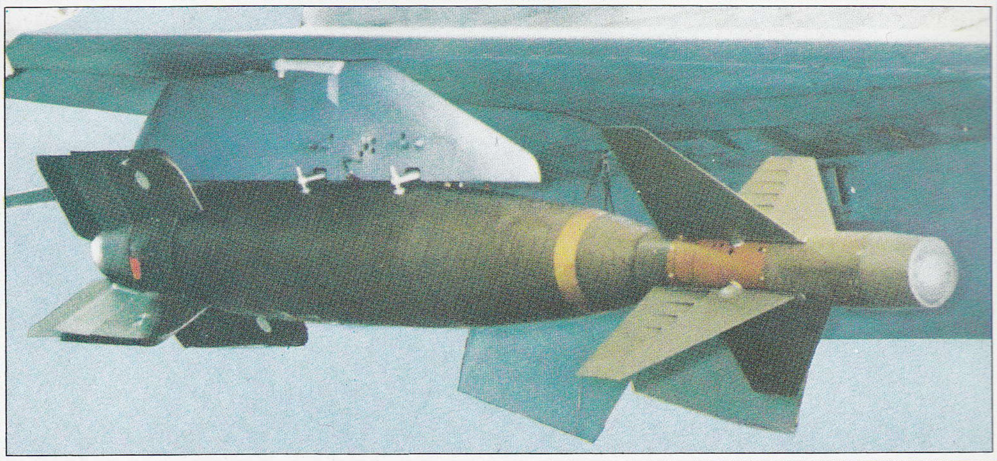
Laser-guided bombs proved themselves the most accurate of the air-delivered anti-armour weapons, but most of the North Vietnamese tanks destroyed by aircraft were actually hit by standard 227-kg (500-lb) Mk 82 GP bombs delivered mainly by South Vietnamese propeller-driven Douglas A-1 Skyraiders and jet-powered Cessna A-37 light attack aircraft. But although these weapon/aircraft combinations scored the most tank kills, they were not as accurate as LGBs and proved highly vulnerable to ground fire compared with the high-flying LGB-equipped F-4 Phantoms on the same mission.

Guided Bombs in Action

The next recorded combat use of the LGB by a Western nation occurred during the Falklands war of 1982, when the Royal Air Force's BAe Harrier GR.Mk 3s of No. 1 Squadron were taken south for use in the ground-attack role. Standard 454-kg (1,000-lb) medium-capacity HE bombs were converted to the LGB configuration by kits parachuted to the task force from long-range Lockheed C-130 Hercules transports on 27 May. The bombs were released singly in a climb from a pre-computed pull-up point to allow the aircraft to remain clear of any air-defence systems. Only after the bomb had passed the highest point of its trajectory and begun its downward path was the target illuminated by a ground-based Ferranti laser designator. From the Two Sisters position on 13 June, designators were used during individual attacks by two aircraft in the course of the day. In each case the first bomb released apparently missed as a result of the target being illuminated too soon, but in each case the follow-up attack with the second weapon scored direct hits, Squadron-Leader Pooks' attack destroying a 105-mm (4.13-in) M56 pack howitzer position.

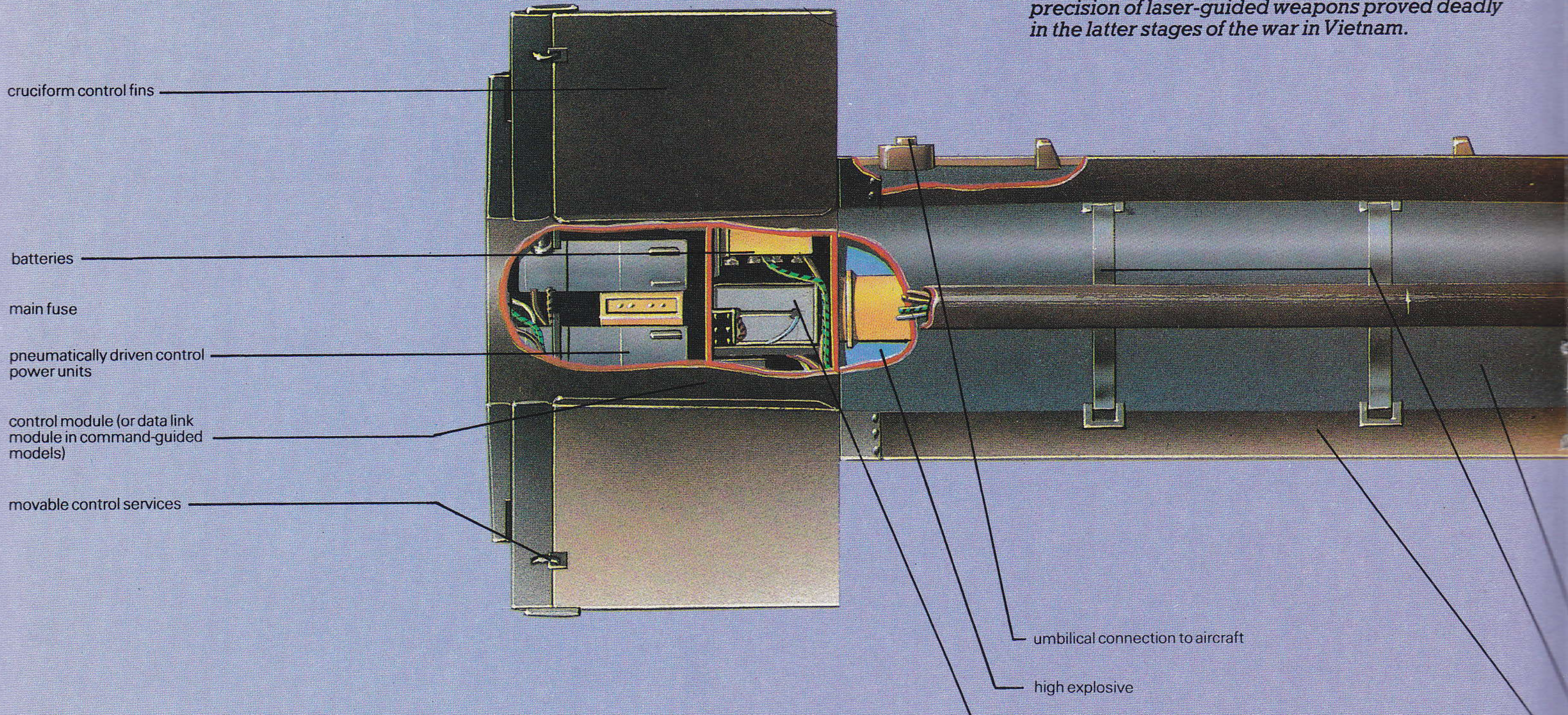
More recently the Soviets have begun to use the LGB in Afghanistan as part of an effort to reduce fixed-wing aircraft losses and to assist their ground troops when they are in close-range fire fights with the guerrillas. There is reason to believe that on several recent occasions conventional bombing attacks have caused more losses to the Soviet and government troops than the *mujahadeen* guerrillas.

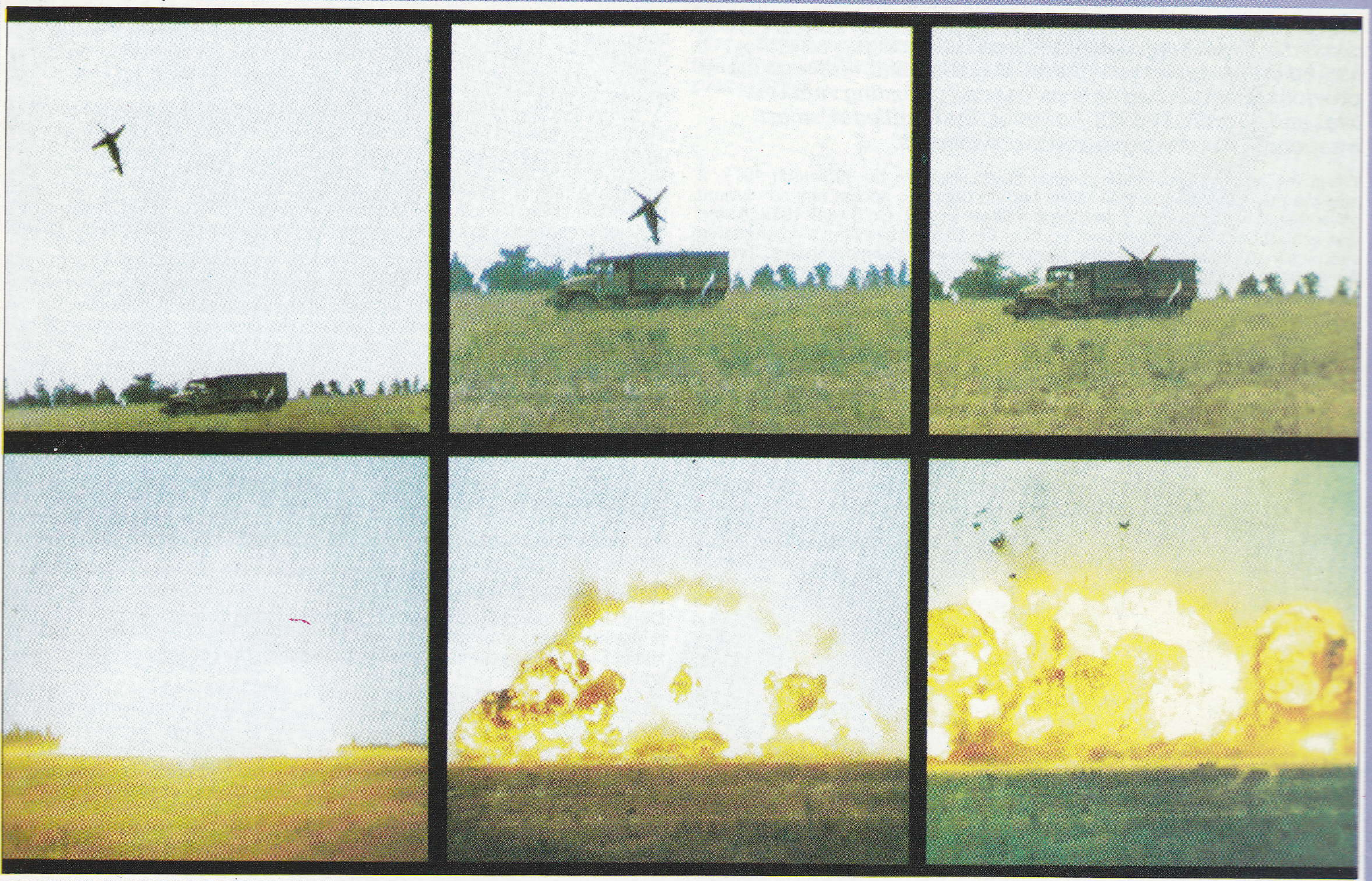
As more countries obtain the LGB, their combat use will become more widespread, and although not yet mentioned in the context of the continuing Iran-Iraq Gulf War, it cannot be long before LGBs are used, if indeed they have not already been employed.



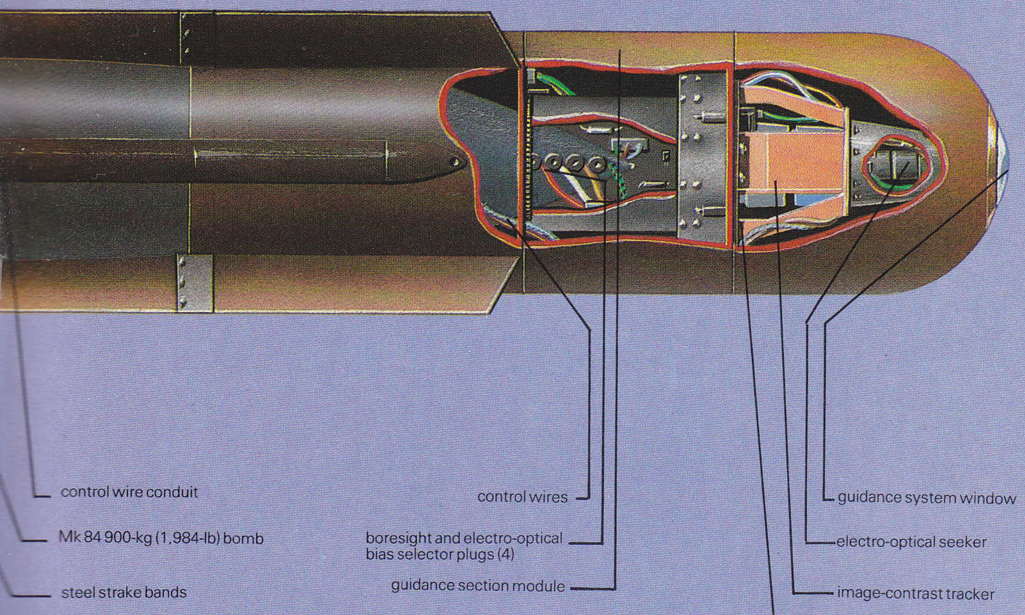
The ordnance to be guided are usually standard weapons, to which have been fitted a seeker head, which senses the laser reflection from a target, a control module, and moveable fins which control the flight.

The combination of the sophisticated all-weather capability of the General Dynamics F-111 with the precision of laser-guided weapons proved deadly in the latter stages of the war in Vietnam.


cruciform control fins
batteries
main fuse
pneumatically driven control power units
control module (or data link module in command-guided models)
movable control services
umbilical connection to aircraft
high explosive
autopilot



Laser guidance was extremely useful not only in eliminating difficult targets in North Vietnam but in providing the closest of close support in the south. As long as a designator could be held on a target, then an air strike could be called in; the accuracy of such a strike is shown here against a fast-moving truck. Such pinpoint targetting allowed attacks to be made without fear of hitting friendly forces.


control wire conduit
Mk 84 900-kg (1,984-lb) bomb
steel strake bands
aerodynamic strakes
control wires
boresight and electro-optical bias selector plugs (4)
guidance section module
guidance system window
electro-optical seeker
image-contrast tracker
gyro-stabilized platform

Left: The HOBOS, or homing bomb system, was developed in parallel with the Paveway programme. Usually fitted to standard Mk 84 900 kg (2000-lb) or Mk 118 1360-kg (3,000-lb) bombs and usually carried by McDonnell Douglas F-4 Phantoms in South East Asia, the original EO (Electro-Optical) guided weapon required the WSO (Weapon Systems Officer) to lock the weapon precisely onto target by centring it in the crosshairs on the monitor screen in the cockpit. Securely locked on, the weapon was released and the aircraft then turned away to seek out a new target.

Daring the Dragon's Jaw

One of the hardest nuts to crack during the whole of the conflict in South East Asia, the Thanh Hoa bridge was well named the 'Dragon's Jaw'. Its fall was essential, although many previous attempts had only succeeded in costing valuable lives and aircraft. By 1972, however, the families of 'smart' weapons in service promised more success.

When the North Vietnamese invaded South Vietnam on 30 March 1972, it became painfully obvious that Hanoi had no desire to accept any settlement other than one dictated by a smashing military victory. On 6 April 1972, American aircraft once again were sent north of the DMZ to carry out a co-ordinated interdiction campaign against the North Vietnamese logistic network. Two of the targets were the Thanh Hoa and Paul Doumer bridges. Since the bombing halt in 1968 they had been repaired, and the rail lines crossing the bridges were being fully utilized.

It was clear to the targeteers, mission planners, and strike pilots that destroying the Thanh Hoa and Doumer bridges would not be a simple task. They had taken their toll of US aircraft and pilots during the early years of the war, and there was no reason to suspect that the defences around them had been softened. There was, however, a glimmer of hope echoing along the halls and in the briefing rooms of the fighter squadrons because some new weapons were now available for such a mission.

A new family of 'smart bombs' had been introduced in South East Asia since the bombing halt in 1968. These weapons consisted of Electro-Optical guided Bombs (EOGBs) and Laser Guided bombs (LGBs) in the 907-kg (2,000-lb) and 1361-kg (3,000-lb) class. The EOGB was a contrast weapon, similar in concept to the Walleye first used in 1967 by the US Navy. The EOGB, however, was a 907-kg bomb with a small TV camera attached to the nose which transmitted a picture of what it was viewing to a scope in the attack aircraft. The pilot would point the aircraft and weapon at the target area, thereby allowing the Weapon Systems Operator (WSO) in the rear cockpit of the McDonnell Douglas F-4 Phantom to find the target on the scope, refine the contrast aiming point and designate the target to the weapon. Once this was accomplished, the pilot would release the bomb and quickly depart the target area, leaving the EOGB to guide itself toward the designated aim point. Target weather and cloud cover was a factor when delivering EOGBs, but if the weapon could see the target when it was released from the aircraft it would usually impact the aim point.

The LGB was somewhat different. A laser sensor was mated to the nose of a 907-kg or 1361-kg bomb which enabled it to guide itself toward a target illuminated with low power laser energy. The problem of illuminating the target with this laser energy was solved by attaching a pod beneath the fighter aircraft. This pod contained an optical viewing system and laser emitting capability, both operated by the WSO in the back seat of the fighter. With this system, the pilot could point his aircraft toward the target while his WSO optically located the precise target aim point and illuminated it with his laser equipment. The pilot would then release his bombs and depart the target area, leaving the LGB to guide itself to the target, which was kept under laser illumination by a swivelling pod or by another aircraft with a laser target designator. An advantage of this system was that more than one aircraft at a time could drop LGBs on the same target, with all weapons using the same illumination point to guide on. Both the EOGB and the LGB resulted in less aircrew exposure and greater accuracy than conventional weapons. A disadvantage was that the target had to be continuously illuminated by the laser for the LGB to be effective. If clouds obstructed the view of the illuminating pod the LGB would become an unguided bomb and probably miss the target.

The new EOGBs and LGBs were given to the 8th Tactical Fighter Wing (TFW) operating F-4 Phantoms from Ubon Royal Thai Air Base, Thailand. The 8th TFW was known as the 'Wolfpack MiG Killers' – a name acquired for their effectiveness in destroying more MiG aircraft during Rolling Thunder than any other US tactical fighter wing operating in North Vietnam. The wing, commanded at this time by Colonel (now Brigadier General) Carl S. Miller, was soon to earn the title of 'Bridge Busters' as a consequence of the wing's use of the new weapons against the North Vietnamese supply system. Between 6 April 1972 and 30 June 1972, the 8th TFW F-4 aircraft were to destroy a total of 106 bridges, including the Paul Doumer and the Thanh Hoa, with the new guided bombs.

In addition to the guided bombs, US air power had increased its capabilities by improving its electronic countermeasures (ECM) through the use of 'chaff' dropped from F-4 aircraft.

Operation 'Freedom Dawn'

With the authorization to re-initiate the bombing of North Vietnam, several air operations plans were drawn up to satisfy the interdiction requirements directed by the upper echelon planners. One of these plans, 'Freedom Dawn', included, among other targets, the Thanh Hoa bridge. The plan called for a small tactical strike force to destroy the Dragon's Jaw with the new family of guided bombs.

The operation was to be carried out by 12 F-4 Phantoms from the 8th TFW, eight of them loaded with 907-kg guided weapons. A flight of four Phantoms was to lay a chaff corridor from the initial point to the target so that the eight bomb-laden F-4s could operate in a relatively sterilized radar environment. Bad weather in the target area had been the cause of several last-minute postponements of the mission, but on 27 April 1972 reports indicated the weather had cleared sufficiently over Thanh Hoa to permit the strike.

On that day, the 12 Phantoms took off from Ubon, and the three flights of four aircraft each headed for an air refuelling area where SAC KC-135 tankers were orbiting, waiting to offload extra fuel to the fighters. This fuel might be necessary should enemy fighters appear or should the RESCAP of a downed aircrew become a reality. Having some extra JP4 fuel might mean the difference between making one last turn to destroy an enemy MiG or being able to orbit a downed crewman and provide suppressive fire against ground forces until SAR aircraft arrived.

With several thousand kilograms of fuel obtained from the tankers, the fighters headed for the bridge. The chaff delivery aircraft had gone out in front to form the protective corridor in advance of the strike aircraft. However, as the strike aircraft approached the IP, a glance in the direction of the target revealed heavy cloud cover which could hamper the use of the guided bombs. The heavy cloud cover and poor visibility precluded the use of LGB illuminators to designate the target continuously, making it a day for the EOGB weapons. The aircraft carrying the EOGBs then positioned themselves for the strike, and let loose their weapons. The extremely heavy anti-aircraft fire filled the skies with hundreds of white, grey and black puffs of smoke from exploding AAA shells. A number of SA-2 SAMs were fired at the aircraft, but SAM effectiveness was reduced by the chaff – so much so that the Phantoms escaped without a scratch. Post-mission photo reconnaissance showed the damage to the bridge to be extensive enough to render it unusable to vehicle traffic. The EOGBs had severely shaken the structure, but stubborn to the end, the Dragon's Jaw would need one more punch.

'Linebacker I'

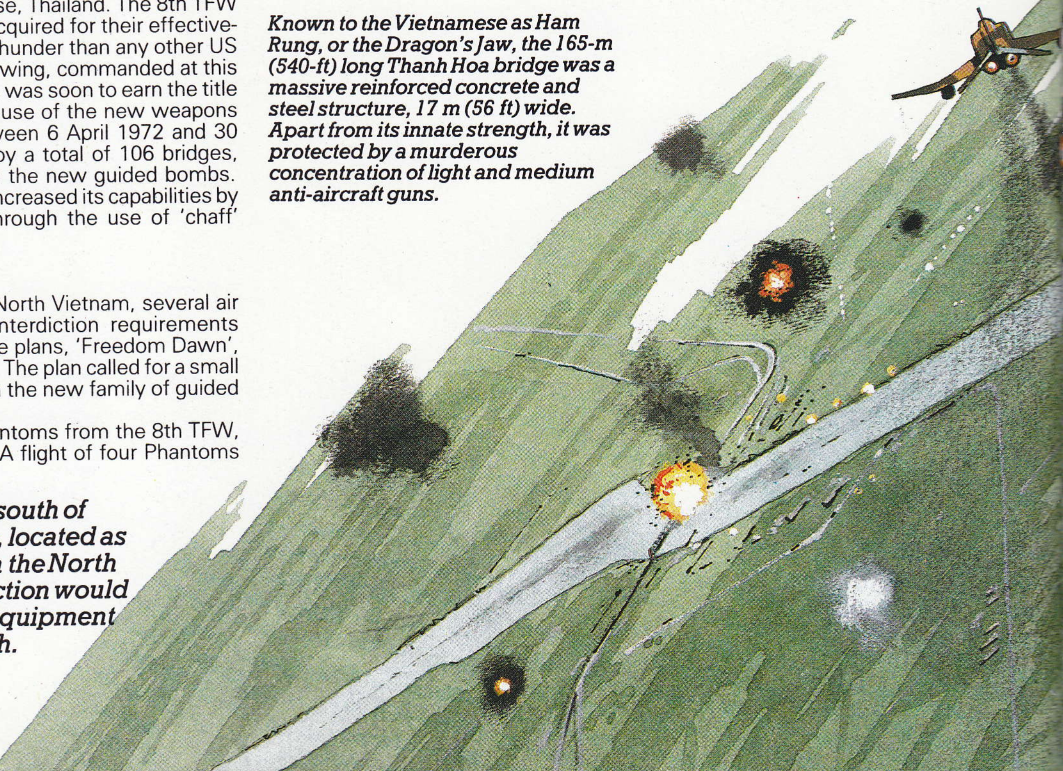
On 10 May, Operation 'Linebacker I', the start of the increased interdiction effort in the north was initiated. Heavy air strikes were flown against targets in the Hanoi-Haiphong area and reduced to rubble many key objectives previously 'off limits'.

After three days of 'Linebacker' activity, the Thanh Hoa bridge was once again highlighted on the daily mission orders, which was to be similar to that flown on 27 April except that the weather was forecast to be better and two additional aircraft were scheduled, making a total of 14 strike aircraft. Guided bombs were on the agenda again; however, this time, nine 1361-kg LGBs would be used in conjunction with 15 907-kg LGBs and 48 227-kg (500-lb) conventional bombs.

On the morning of 13 May, the attacking force members annotated their maps with updated SAM plots and received final briefings on enemy AAA defences, air refuelling tracks, positions of supporting ECM forces and the SAR procedures. The target weather was briefed as good. The strike group took off on schedule and rendezvoused with the KC-135 tankers for the pre-strike refuelling.

The pilots then set an easterly course across southern North Vietnam to the Gulf of Tonkin, and from there north to the target area. Approaching the target, everyone could see that the weather forecaster had been correct. No trouble – some clouds were evident and the flights positioned for the attack.

With the target in sight, the lead aircraft rolled in for the kill, unleashing his LGBs at the bridge. Plane after plane followed, with each pilot hoping that the anti-aircraft flashes on the ground did not signal a shot destined for his aircraft. As they dropped more bombs on the target, the last few pilots saw large clouds of dust and belches of fire as the bombs exploded on the bridge. After the final



Known to the Vietnamese as Ham Rung, or the Dragon's Jaw, the 165-m (540-ft) long Thanh Hoa bridge was a massive reinforced concrete and steel structure, 17 m (56 ft) wide. Apart from its innate strength, it was protected by a murderous concentration of light and medium anti-aircraft guns.

The Thanh Hoa bridge, 112 km (70 miles) south of Hanoi, was a major target for US air attack, located as it was on the main road and rail route from the North into Laos and to South Vietnam. Its destruction would seriously hamper the movement of men, equipment and supplies to the battlefields of the South.

aircraft had pulled away from the target, the strike pilots knew the bridge was down and headed for home – misson accomplished.

No aircraft had been damaged, even though the AAA and SAM fire had been intense. Post-strike photography by RF-4Cs confirmed the strike pilots' assessment. The western span of the bridge had been knocked completely off its 12-m (40 ft) thick concrete abutment and the bridge superstructure was so critically disfigured and twisted that rail traffic would come to a standstill for at least several months.

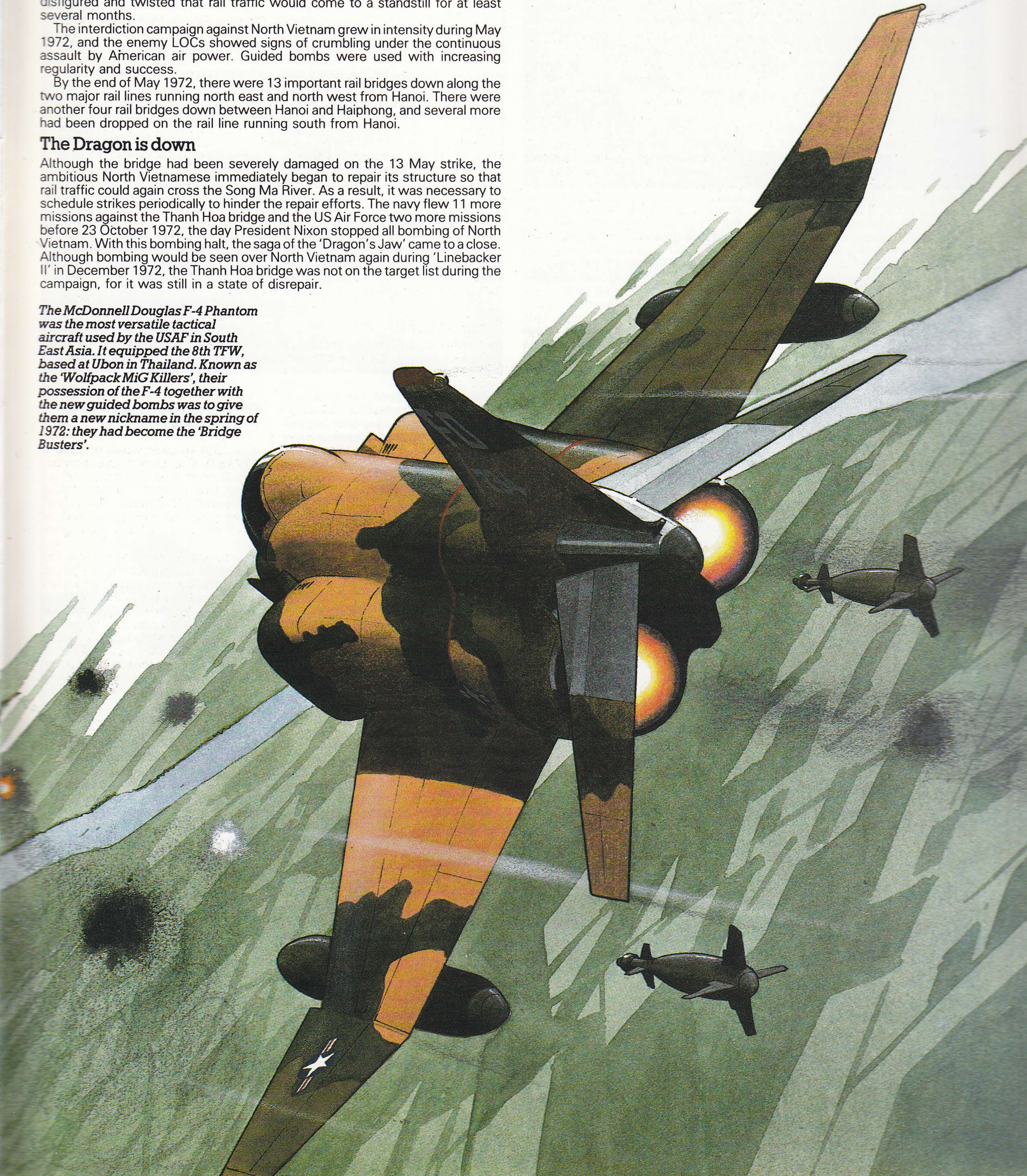
The interdiction campaign against North Vietnam grew in intensity during May 1972, and the enemy LOCs showed signs of crumbling under the continuous assault by American air power. Guided bombs were used with increasing regularity and success.

By the end of May 1972, there were 13 important rail bridges down along the two major rail lines running north east and north west from Hanoi. There were another four rail bridges down between Hanoi and Haiphong, and several more had been dropped on the rail line running south from Hanoi.

The Dragon is down

Although the bridge had been severely damaged on the 13 May strike, the ambitious North Vietnamese immediately began to repair its structure so that rail traffic could again cross the Song Ma River. As a result, it was necessary to schedule strikes periodically to hinder the repair efforts. The navy flew 11 more missions against the Thanh Hoa bridge and the US Air Force two more missions before 23 October 1972, the day President Nixon stopped all bombing of North Vietnam. With this bombing halt, the saga of the 'Dragon's Jaw' came to a close. Although bombing would be seen over North Vietnam again during 'Linebacker II' in December 1972, the Thanh Hoa bridge was not on the target list during the campaign, for it was still in a state of disrepair.

Early strikes against the bridge had shown that bombs of less than 450 kg (1,000 lb) did little more than tickle the massively constructed bridge. For the 1972 strikes, the guided bombs were all in the 900 to 1360 kg (2,000 to 3,000 lb) class. The attacks of 27 April and 13 May were to be the knockout punch to the Dragon's Jaw.



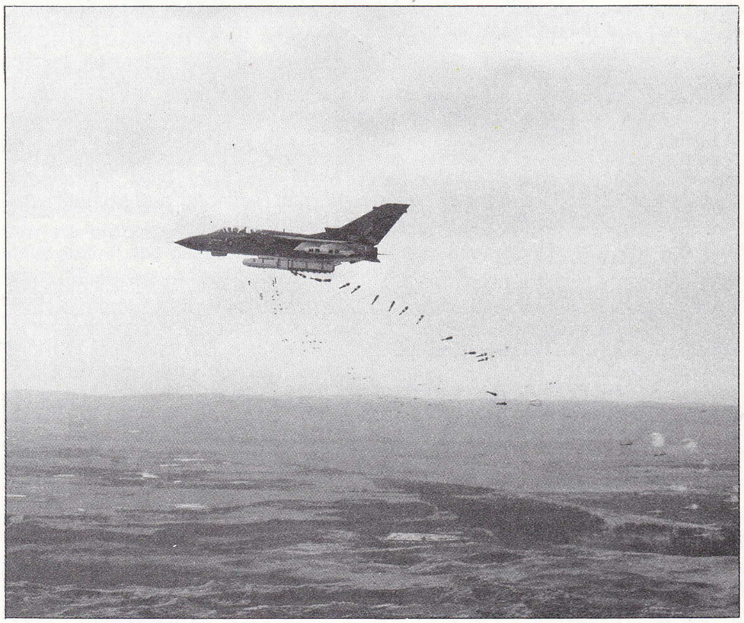
The McDonnell Douglas F-4 Phantom was the most versatile tactical aircraft used by the USAF in South East Asia. It equipped the 8th TFW, based at Ubon in Thailand. Known as the 'Wolfpack MiG Killers', their possession of the F-4 together with the new guided bombs was to give them a new nickname in the spring of 1972: they had become the 'Bridge Busters'.

UK/WEST GERMANY

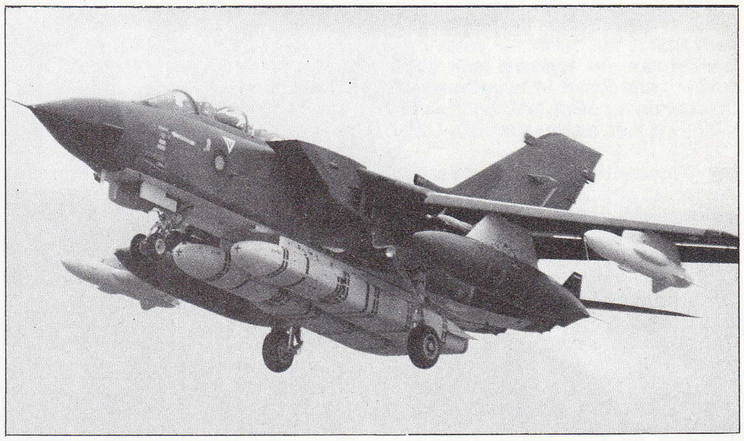
Hunting Engineering JP233 and Raketen-Technik GmbH (RTG) Mehrzweckwaffe-1 (MW-1) dispenser weapons

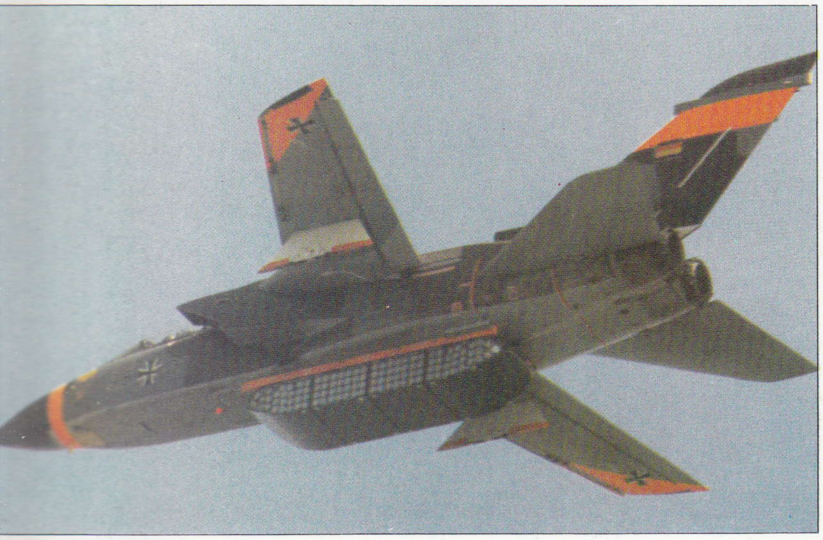
To arm their Panavia Tornado strike and interdiction aircraft, the British and West Germans independently designed and built large container dispenser weapons for installation beneath the fuselage. The **Hunting JP233**, although originally a joint venture with the Americans, will be primarily used by the Royal Air Force in counter-air operations to close Warsaw Pact airfields whilst retaining the capability to be used against other types of targets where large-scale disruption of military movements is required. To accomplish these objectives two types of submunitions are dispensed: that designated SG357 is designed to damage and render inoperative such facilities as concrete runways, taxiways and grass operating strips, whilst the HB876 area-denial submunition is designed as a continuous threat to vehicles or personnel trying to repair the crater damage caused by the SG357. To ensure an effective coverage of the target area, both types are dispensed simultaneously in a co-ordinated sequence of 30 SG357s and 215 HB876s. Each Royal Air Force Tornado will carry two of the JP233 pods, and the dispenser can also be configured for carriage by aircraft such as the General Dynamics F-16 Fighting Falcon.

In contrast with the British approach, the West Germans have developed the **RTG MW-1** multi-purpose dispenser for use against airfields and massed armoured units on the move. The submunitions carried are thus divided into two main-target groups that can be preset just before firing to be scattered over an area about 500 m (1,640 ft) wide and up to 4000 m (13,125 ft) long depending upon the target's nature and concentration. For the anti-armour mission the MW-1 carries Group 1, which comprises 672 MIFF anti-armour mines (each with two back-to-back HEAT warheads), or 4,500 KB44 anti-armour/anti-personnel shaped-charge fragmentation bomblets, or a combination of the two. This version has already entered Luftwaffe service, whereas Group 2 for anti-airfield use will not be in service until 1987. This group comprises either a single load of 224 STABO braked dual-warhead cratering munitions or various combinations of 672 MIFF mines, MUSA delayed-action fragmentation minelets and MUSPA acoustically-activated area-denial mines. This means that to close a runway effectively several Luftwaffe Tornados will have to overfly the runway to cut it with STABO-filled MW-1s whilst others sow the surrounding areas with the mixed loads of area-denial submunitions. The Italian air force has also ordered the anti-runway MW-1 in a modified form carrying only a STABO payload.



A Tornado disgorges a shower of submunitions from its JP233 dispensers. Conventional bombs can crater a runway, but holes can quickly be filled; the 30 SG357 bomblets in the JP233 penetrate and fracture a huge area of the concrete surface.



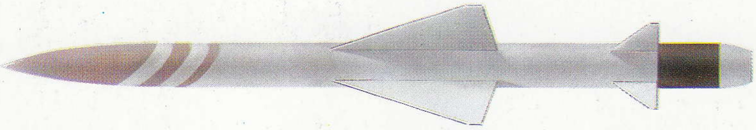


Left: As with most of the modern family of dispenser weapons, the MW-1 can carry a wide variety of submunitions, including anti-armour mines for dealing with tank formations or cratering weapons to render enemy airfields unusable.

Above: The JP233 is more specifically designed for the airfield denial role, with its cratering submunitions being seconded by anti-vehicle and anti-personnel weapons designed to hamper any runway repair efforts.

UK

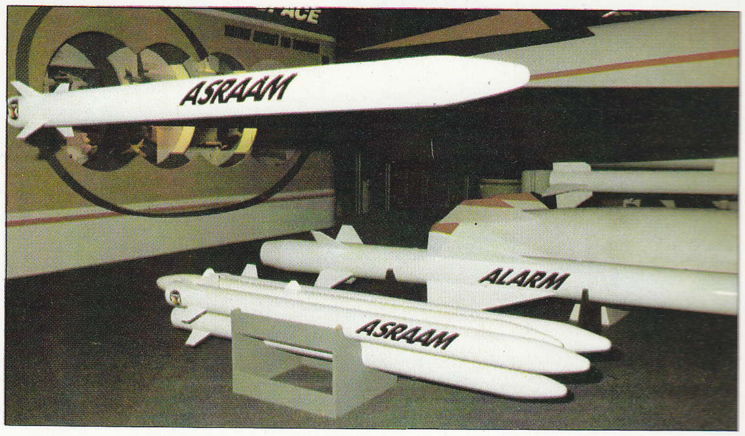
British Aerospace Dynamics Group/Marconi Space and Defence Systems Air-Launched Anti-Radar Missile (ALARM)



Left: Similar to Sky Flash in size, the ALARM missile has been chosen to provide the Royal Air Force with state-of-the-art defence suppression.

The **BAe/MSDS ALARM** was developed to meet the early 1980s requirement of Air Staff Target (AST) 1228, and was in direct competition with the American AGM-88 HARM for a total Royal Air Force buy of around 2,000 rounds. In July 1983 it was announced that the ALARM was the chosen missile, with the first production rounds to enter service in 1987. The design rationale of ALARM is that it is an autonomous system light enough for several to be carried on a strike aircraft in addition to its normal interdiction payload. The weight is thought to be around 175 kg (385 lb), and the weapon can be fitted to fixed-wing aircraft down to the size of the BAe Hawk as well as to larger machines such as the Panavia Tornado; the missile can also be installed on helicopters.

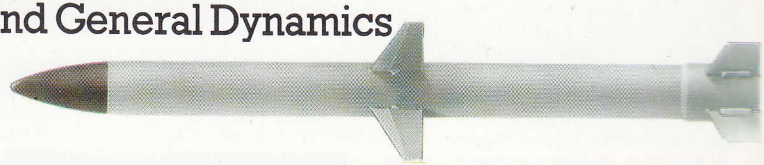
No reliable specifications of the missile have yet been released, but the configuration appears to follow that of the Sky Flash AAM though with a larger body allied to smaller wings and control surfaces. Two modes of operation will apparently be used: the self-defence mode, whereby the sophisticated Marconi broad-band seeker locks onto an emitting radar whilst the missile is still on the carrier; and the defence-suppression parachute mode, whereby the missile is fired as the aircraft approaches the target. The ALARM then zooms up under powered flight to a height of around 12190 m (40,000 ft), where it cuts its motor and pitches over to point downwards at the end of a drogue parachute deployed after the motor is cut. The seeker then begins a search for radar emitters, from which the most important signal is identified, and then commands the missile to discard the parachute and relight the rocket motor so the missile can attack the chosen source. At present the Royal Air Force uses limited stocks of the American AGM-45 Shrike and the AS.37 ARM version of the Anglo-French Martel ASM for the defence-suppression task.



The sophisticated electronics and guidance planned for ALARM promise an extremely capable missile that can deal with a wide range of targets. Nevertheless, it is still in the early stages of development.

USA

Texas Instruments AGM-45 Shrike and General Dynamics AGM-78 Standard ARM



Based upon the AIM-7 Sparrow AAM airframe, the Texas Instruments Shrike has a larger warhead and less powerful rocket motor. Although used extensively, the performance is less than satisfactory.

Specialized anti-radar missiles (ARMs) were developed by the US Navy from 1958 onwards as a means of improving the survivability of conventional attack aircraft, either by deterring the enemy from operating his defensive radar or by directly destroying the radar's antenna. The first tactical ARM to enter production was the **Texas Instruments AGM-45A Shrike** in 1963. This was essentially a Sparrow AAM airframe with an enlarged blast-fragmentation warhead and a smaller rocket motor. Although used extensively by the US forces in Vietnam, by Israel against the Arabs and by the UK in the 1982 Falklands war, the Shrike has displayed a not altogether satisfactory performance as a result of design limitations associated primarily with the seeker. There are no memory circuits available, and this means that the shutdown of the radar being attacked causes the missile to go ballistic. The seeker is also rigidly mounted, so the missile must be pointed towards the target at launch, and the seeker has to be tuned before take-off to the wavelength band of the radar system under attack, otherwise it cannot pick up any emissions. A total of 13 different seekers to cover likely target systems has thus been developed. Total production for the USAF and US Navy was about 18,500 rounds, the larger number going to the former service, which uses it primarily on the McDonnell Douglas F-4G Phantom 'Wild Weasel II' defence-suppression aircraft together with the **General Dynamics AGM-78 Standard ARM**.

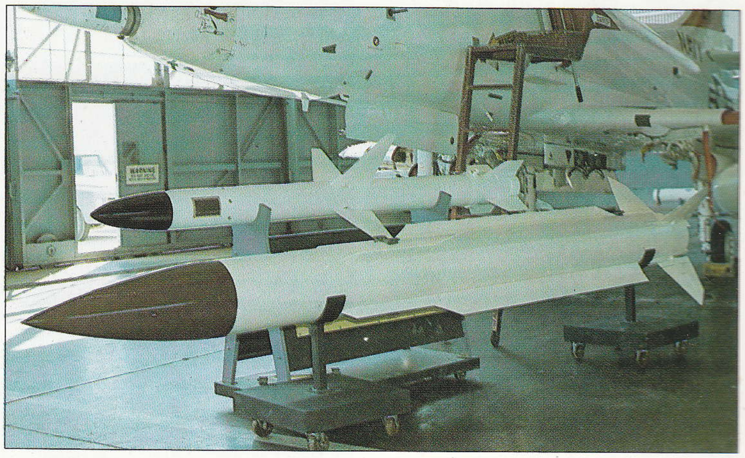
The latter missile was contracted in 1966 because the Shrike's combat performance was found to be bad. Designated **AGM-78A Standard** in its initial form, it was based on the Standard shipboard SAM and initially equipped with the Shrike seeker with all its faults. Production soon shifted to the **AGM-78B** version with a gimballed wide-band seeker and a memory circuit that required no pretuning, thus permitting an attack even if the radar had ceased emitting signals. An **AGM-78C** variant was then produced for the US Air Force, the subsequent **AGM-78D** and **AGM-78D2** models further increasing the seeker capabilities. Over 3,000 rounds had been built by the time the last delivery of a batch of AGM-78D2 missiles was made in August 1976. Ultimately both the Shrike and Standard will be replaced by the AGM-88A HARM, and current operators of the type are Israel (not certainly), South Korea, the US Air Force, US Marine Corps and US Navy. The Shrike is in slightly more widespread service, current operators including Iran, Israel, the UK, US Air Force, US Marine Corps and US Navy.

Specification
AGM-45 Shrike

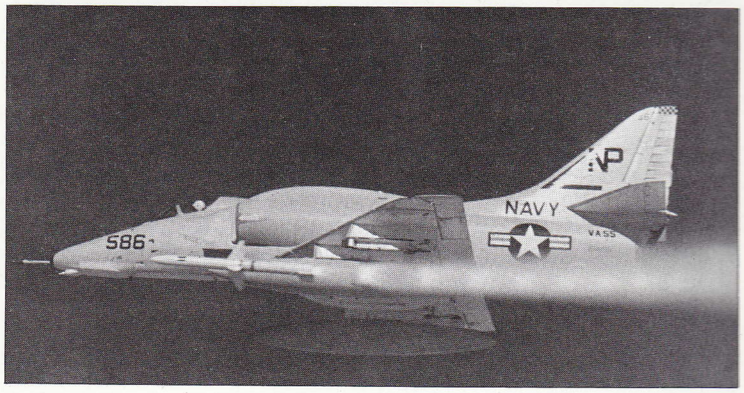
Type: anti-radiation air-to-surface missile
Dimensions: length 3.048 m (10 ft 0 in); span 0.914 m (3 ft 0 in); diameter 0.203 m (8 in)
Launch weight: 176.9 kg (390 lb)
Propulsion: solid-propellant rocket motor
Performance: speed Mach 2; range 46.5 km (28.9 miles); CEP reasonable if the target radar continues to emit
Guidance: passive radar-homing
Warhead: 65.8-kg (145-lb) HE blast fragmentation

Specification
AGM-78 Standard ARM

Type: anti-radiation air-to-surface missile
Dimensions: length 4.572 m (15 ft 0 in); span 1.092 m (3 ft 7 in); diameter 0.343 m (13.5 in)
Launch weight: 615.1 kg (1,356 lb)
Propulsion: solid-propellant rocket motor
Performance: speed Mach 2.5; range 112.65+ km (70+ miles); CEP good even if the target radar ceases transmitting
Guidance: passive radar-homing
Warhead: 97.4-kg (214.7-lb) HE blast fragmentation

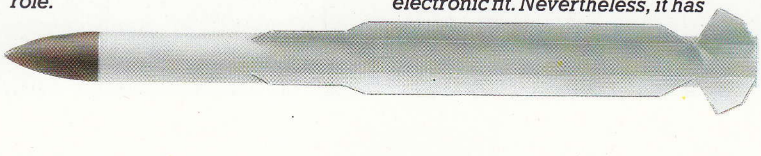


Above: The much larger and more capable Standard ARM (foreground) is replacing the Shrike (background) in US service. Developed from the Standard naval SAM, the ARM has a memory circuit which enables it to attack a radar site even when it has stopped transmitting.



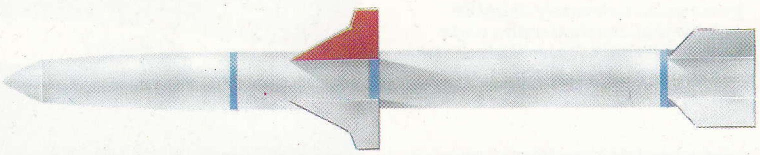
Above: The small size of the Shrike (seen here mounted on a Douglas A-4 Skyhawk of the US Navy) limits the electronic fit. Nevertheless, it has been used to great effect by Israel to deal with Syrian missile sites in the Lebanon.

Below: Developed from a naval area defence missile, the Standard ARM has the excellent range of over 112 km (70 miles). The missile is also available to be fired from Standard-equipped ships for the anti-radar role.



USA

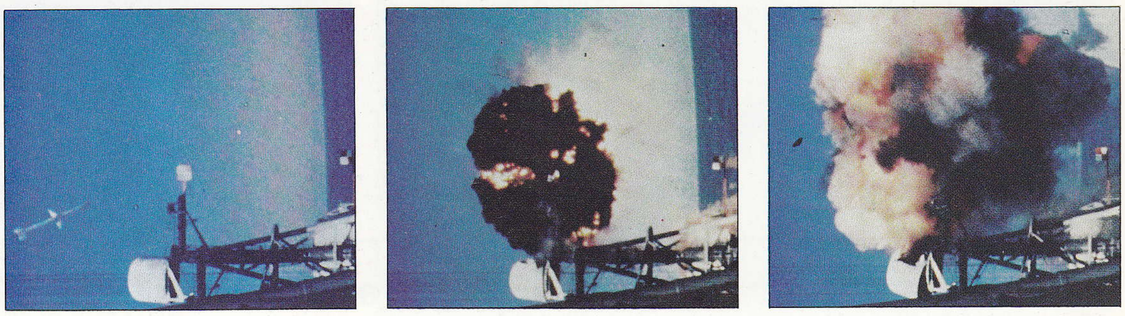
Texas Instruments AGM-88A High-speed Anti-Radiation Missile (HARM)



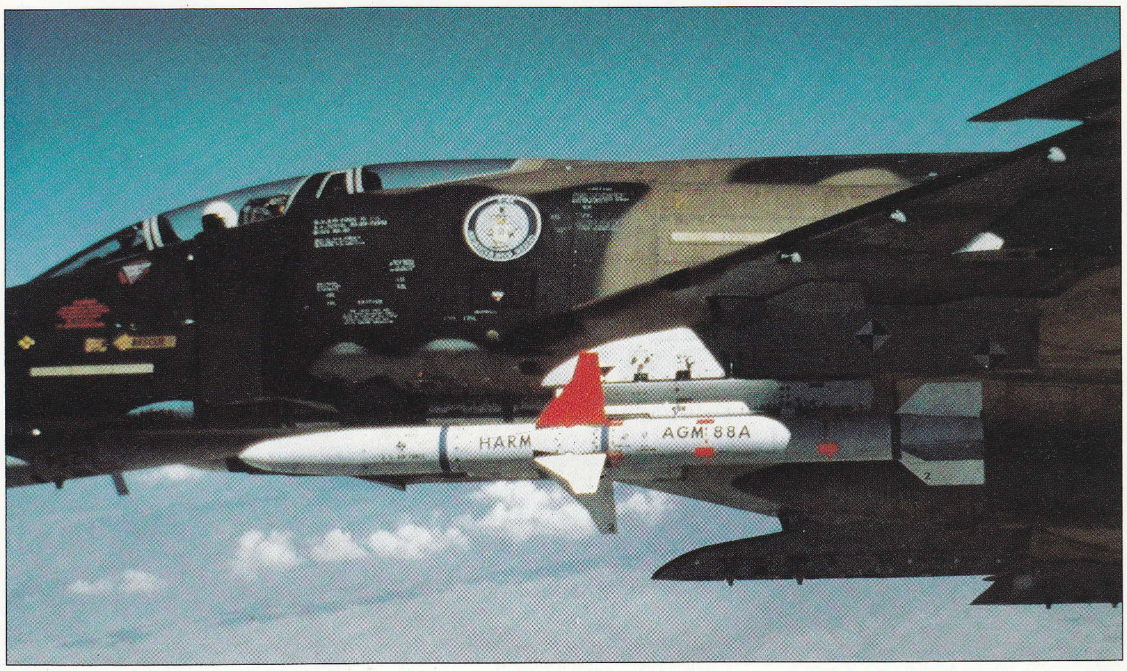
Similar in appearance to the Shrike missile it will replace, HARM (High-speed Anti-Radiation Missile) is a larger weapon with a greatly improved performance. It will also replace the Standard ARM, having similar performance with much improved electronics.

Although the Standard ARM was an improvement on the Shrike, its combat performance in Vietnam was still not very inspiring as its memory circuits proved less than satisfactory. Also the Standard was five times costlier and three times heavier than the Shrike, so a requirement for a new ARM was established. The result was the **Texas Instruments AGM-88A HARM**, which emphasizes high speed so that any defending radar operator has only minimum warning times to 'shut down' his system; this attacker's advantage is multiplied by the fact that the launch platform does not need to execute any characteristic launch manoeuvre.

Initial development of the HARM began in late 1969 by the US Navy, but progress was halted by severe technical problems which were not resolved until 1973. Further delays were then experienced with the Texas Instruments guidance seeker and initial production deliveries were not made until 1983. The missile has three modes of operation: the self-protection mode, in which a threat receiver on the launch platform detects a radar signal and programmes the missiles seeker before it is fired; the 'target-of-opportunity' mode, in which the sensitive seeker on the missile itself locks on to an emitting radar; and the 'pre-briefed' mode, in which the missile is fired blind in the general direction of a possible target with its seeker searching for a signal onto which the missile can home. In the last mode, failure to detect a signal initiates a programme for self-destruction. Like its two predecessors, the HARM can also be fired in a 'loft' manoeuvre to increase its range, the target being acquired on the downward portion of the trajectory. The warhead is detonated at a preset height over the target by a laser proximity fuse in order to maximize damage to the antenna and electronics.



Travelling at more than 3200 km/h (2,000 mph), this sequence of HARM in its final approach would take a split second. Designed to use its very high speed to give the opposing radar operator as little time as possible to switch off when detected, HARM destroys its targets by means of a 66-kg (145-lb) high-explosive blast warhead.



Carried on a McDonnell Douglas F-4G Phantom, HARM missiles are just entering US service. Initial requirement was for almost 700 missiles, at a unit cost of nearly a million dollars per missile, with even larger numbers to be procured in the years to come.

Specification

AGM-88A

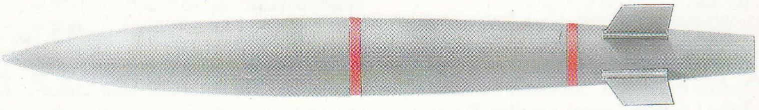
Type: anti-radiation air-to-surface missile
Dimensions: length 4.171 m (13 ft 8.2 in); span 1.118 m (3 ft 8 in); diameter 0.254 m (10 in)
Launch weight: 361.1 kg (796 lb)
Propulsion: solid-propellant rocket
Performance: speed Mach 3+; range 74.4+ km (46.25+ miles); CEP very good
Guidance: passive radar-homing
Warhead: 65.8-kg (145-lb) HE blast fragmentation

USA

Boeing AGM-69A Short-Range Attack Missile (SRAM)

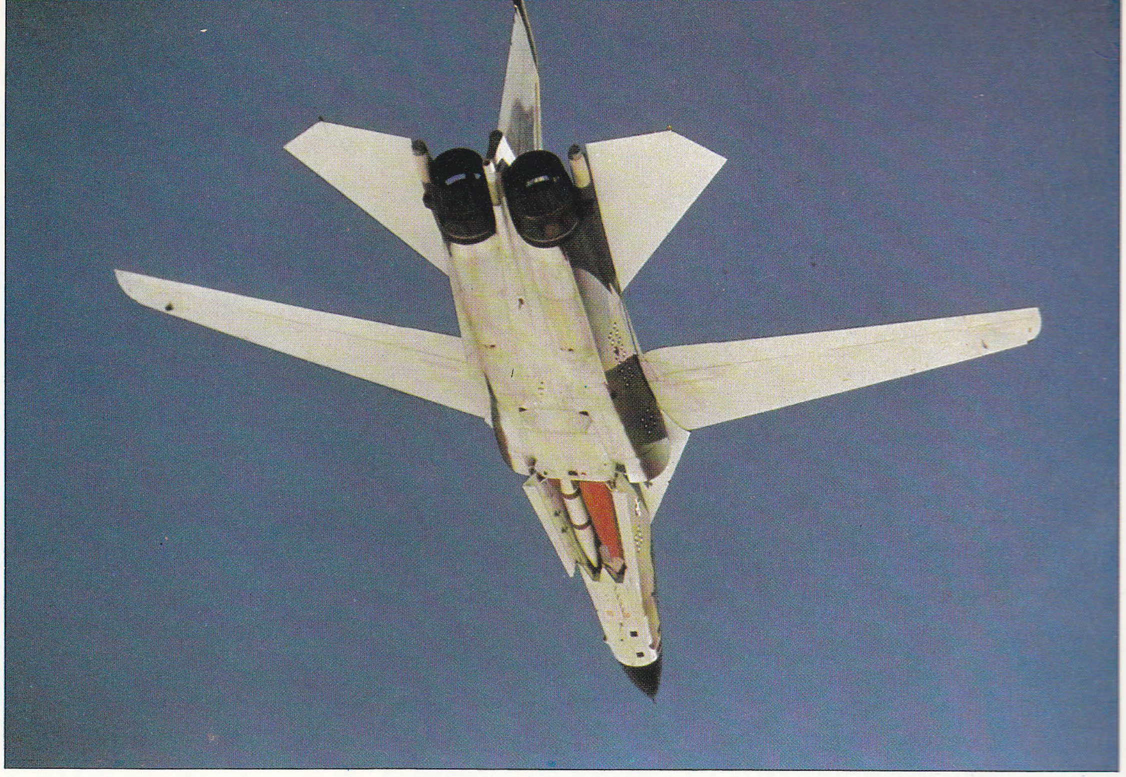
In 1964 the US Air Force began development of the **Boeing AGM-69A SRAM**, for use primarily against major defensive installations deep within enemy territory whilst the launch platform remains outside the enemy's engagement zone. The missile was also required to attack main-mission targets as well if they were suitable or if they had exceptionally heavy anti-aircraft defences. The first production round was delivered to the Strategic Air Command in 1972, the last of 1,500 being delivered three years later. Some 1,150 SRAMs currently remain in the operational inventory. The major carrier of the type is the Boeing Stratofortress, the B-52G and B-52H models each being able to carry 20 missiles. The more usual load is six or eight SRAMs as well as four free-fall thermonuclear gravity bombs. The General Dynamics FB-111A can carry up to six SRAMs, but those aircraft which do carry them as part of their normal weapons load only have just two.

Four basic flight profiles can be utilized in an attack: semi-ballistic from the point of launch to the target; altimeter-controlled terrain-following; ballistic pull-up from behind screening terrain using inertially-guided flight for the terminal phase; and a combination of inertial and terrain-following. Each profile can further be enhanced by the programming into the missile's onboard guidance system of deviations in direction of up to 180°. The range depends entirely upon what launch altitude and flight profile is chosen. Once over the target the warhead can either detonate on contact to give a ground burst or at a preset altitude to give an air burst nuclear explosion, the type of explosion being chosen according to the target type and the damage level required. The missile's computer can be retargeted at any time up to launch. The SRAM is expected to stay in service for a number of years to come.



Equipping Strategic Air Command's bomber force, the AGM-69A SRAM (Short Range Attack Missile) is mainly designed for interdiction duties deep behind enemy lines.

Specification
AGM-69A
Type: short-range air-to-surface strategic missile
Dimensions: length 4.267 m (14 ft 0 in) fo internal carriage or 4.826 m (15 ft 10 in) for external carriage; span 0.762 m (2 ft 6 in); diameter 0.445 m (17.5 in)
Launch weight: 1016 kg (2,240 lb)
Propulsion: two solid-propellant rocket motors
Performance: speed Mach 3.5; range between 56.3 and 80.5 km (35 and 50 miles) at low altitude, or between 160.9 and 221.3 km (100 and 137.5 miles) at high altitude; CEP 457 m (500 yards)
Guidance: inertial
Warhead: W69 170-kiloton yield nuclear



SRAM is carried by Boeing B-52G bombers and by the FB-111 of SAC. The SRAM's Mach 3.5 speed and low-level range of up to 80 km (50 miles) allow bombers to make stand off attacks.

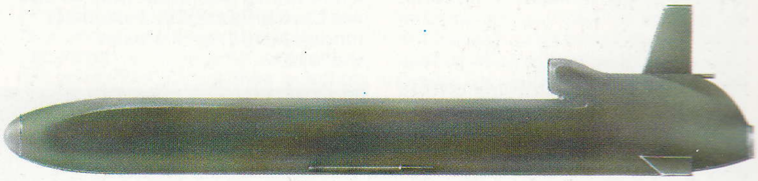
USA

Boeing AGM-86 Air-Launched Cruise Missile (ALCM)

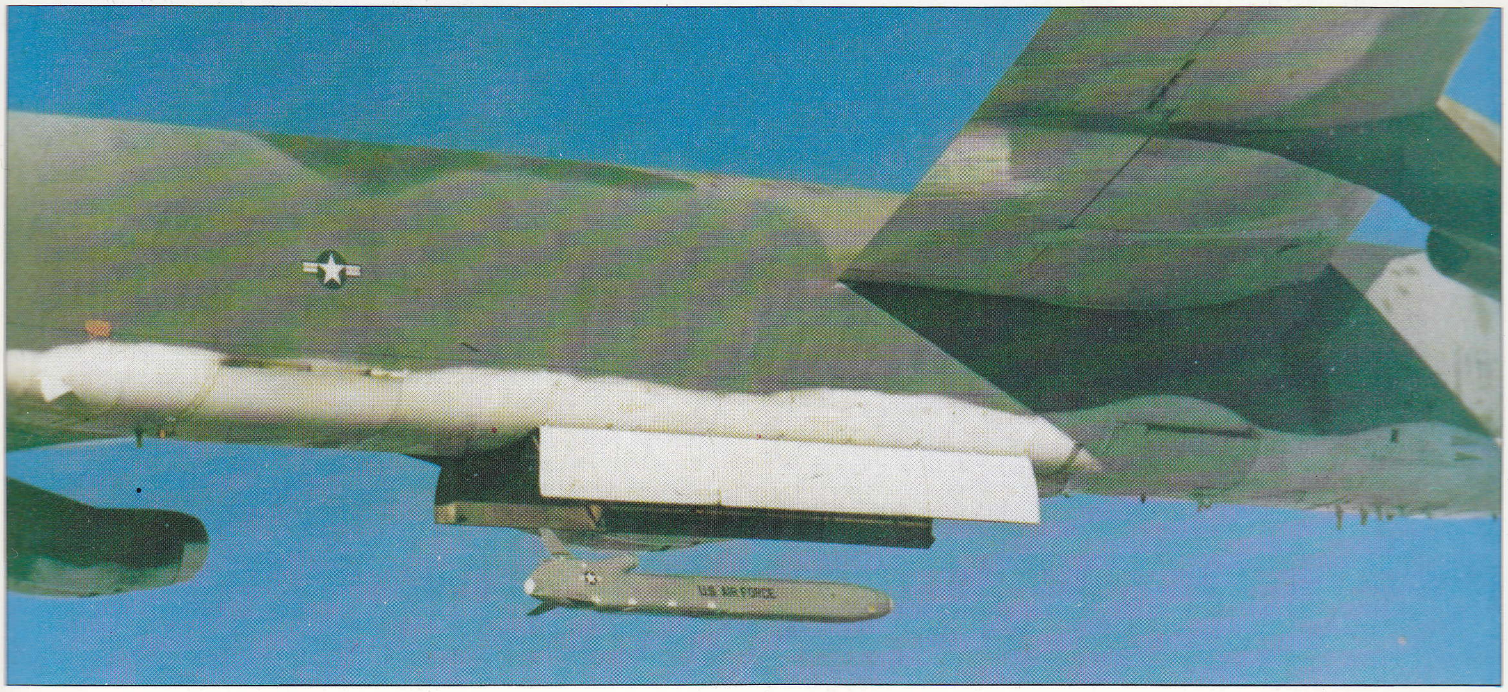
The **Boeing ALCM** is the result of a US Air Force requirement to provide an air-launched strategic weapon for deployment on the Boeing B-52 bomber and successor designs.

The original **AGM-86A** was to be interchangeable with the AGM-69A SRAM on the latter's internal B-52 eight-round rotary launcher. However, because the weapon was considered to be short on range, and because of a Department of Defense's 1979 decision to hold a fly-off between the AGM-86A and the General Dynamics AGM-109 Tomahawk cruise missile, a considerably stretched version, the **AGM-86B**, was produced. This was some 30 per cent longer and effectively doubled the missile's range for a given warhead.

In 1980, following a considerable delay in announcing the results, the US Air Force revealed that the AGM-86B was the chosen weapon. The first two rounds were delivered to the Strategic Air Command in 1981. The B-52G is being modified to carry 12 AGM-86B missiles on two underwing pylons whilst retaining its internal load of SRAMs and free-fall nuclear bombs. The more modern B-52H will have the same external pylon load, but the bomb bay of each aircraft is to be rebuilt to accommodate an additional eight ALCMs on a new rotary launcher. The follow-on Rockwell B-1B will be able to contain the same internal rotary launcher and up to 14 more ALCMs will be carried on external racks. A total of 4,348 ALCMs is planned before production switches to the Advanced Cruise Missile design.



With a range in excess of 3000 km (1,850 miles), the AGM-68B gives the USAF a weapon which will enable its bombers to make strategic attacks without having to face the task of trying to penetrate modern defences.



B-52H aircraft are being modified to accept a rotary ALCM launcher in their bomb bays. Cruise missile carriers are to be fitted with special leading edge extensions, in accordance with the SALT treaties, to enable identification by surveillance satellites.

Boeing AGM-86 ALCM (continued)

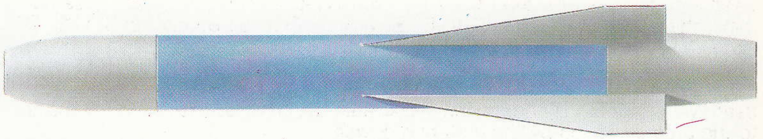
Specification
AGM-86B
Type: air-launched strategic cruise missile
Dimensions: length 6.325 m (20 ft 9 in); span 3.658 m (12 ft 0 in); diameter 0.693 m (27.3 in)
Launch weight: 1281.4 kg (2,825 lb)
Propulsion: one turbofan
Performance: speed 805 km/h. (500 mph); range 3138 km (1,950 miles); CEP between 10 and 30 m (32.8 and 98.4 ft)
Guidance: inertial with terrain contour updating
Warhead: W80-1 200-kiloton yield nuclear

Major carrier of ALCMs will be the Rockwell B-1B bomber. Until it enters service, the trusty old B-52 (some of which are older than their pilots!) will remain the primary delivery system. The B-1B will carry 8 missiles internally and 26 on underwing pylons.

USAF
ALCM
USAF
ALCM

USA

Hughes/Martin AGM-62 Walleye



Right: Television guided, the Walleye is a 3.54 m (11 ft 4 in) glide bomb with a 375 kg (825-lb) shaped charge warhead in its original form. Later models have a much greater warload.

65
NMC
2651
NAVY

Walleye II is seen aboard an US Navy Corsair. Most recent development of Walleye has centred around the ER/DL modification; larger wings extend the glide range and enhanced electronics allow the missile to be released before lock-on, subsequent guidance being provided by a data link.

Developed from 1963 onwards by the US Naval Weapons Center at China Lake, with first production deliveries by Hughes in 1966 and by second-source contractor Martin Marietta in 1967, the **Hughes/Martin AGM-62 Walleye** family of TV-guided unpowered glide bombs entered into the US Navy's weapon inventory in the latter year. The first version was the **AGM-62A Walleye I**, of which 4,531 were produced. This could be carried at speeds up to Mach 1.9 and be launched from altitudes up to 10670 m (35,000 ft). It was used extensively in the Vietnam War, 920 being used in the 1972 'Linebacker II' missions alone. Its targets were mainly large buildings with interior contrast windows and various types of bridges. Against the 'soft' wooden bridge structures the results were excellent, but when a 'hard' bridge (requiring a span to be destroyed) was attacked the result was usually only bent girders. As the warhead was not large enough to attack such 'hard' targets, Martin Marietta converted 1,481 of the Walleye Is and built 529 new missiles to the longer-range **Walleye II** configuration, with a warhead over twice the original size and a new seeker with a smaller 'gate' for slightly greater accuracy. The Walleye guidance system allows the pilot to lock-on before launch, launch the weapon and then exit the area. The only requirement is that the selected target must contrast sharply (in visual terms) with its surroundings so that the gyro-stabilized TV camera in the Walleye's nose can be 'gated' before launch to remain pointing at the area of high contrast and thus guide the missile in flight. As it closes the target the Walleye II gains accuracy since the image it sees is expanded in the TV system's field of view.

To extend the range of the missile still farther, a lock-on-after-launch variant was introduced. This required a two-way data-link so that the pilot in the retiring aircraft could see the TV picture in order to select a target and command the lock-on. The result was the **Extended-Range Data-Link (ERDL) Walleye**, which entered initial production in 1972. A total of 1,400 Walleye I and 2,400 Walleye II rounds have been converted to this configuration. The US Navy prefers to use a two-aircraft formation with this weapon, one to carry and launch the missile, and the other to order lock-on or guide it manually all the way to the target using the data-link pod. Three ERDL Walleye IIs were combat-tested against targets invisible to the pilot at the time of launch during the 1972 bombing of North Vietnam, and all three scored direct hits. A nuclear version of the Walleye I, with the 100-kiloton yield W72 warhead, was also operated by the US Navy between 1970 and 1979. Against tank-sized targets the maximum range of most of the USA's guided weapons is 4.8 km (3 miles). The Walleye is also used by Israel.

Specification
Walleye series
Type: guided glide bomb
Dimensions: length (Walleye I) 3.454 m (11 ft 4 in) and (Walleye II) 4.039 m (13 ft 3 in); span (Walleye I) 1.156 m (3 ft 9.5 in) and (Walleye II) 1.295 m (4 ft 3 in); diameter (Walleye I) 0.318 m (12.5 in) and (Walleye II) 0.457 m (18 in)
Launch weight: (Walleye I) 512.6 kg (1,130 lb) and (Walleye II) 1061.4 kg (2,340 lb)
Performance: range (Walleye I) between 1.8 and 29.6 km (1.12 and 18.4 miles) and (Walleye II) between 1.8 and 45 km (1.12 and 28 miles), while ERDL versions have a maximum range extended by at least 30 per cent; CEP between 4.6 and 6.1 m (15 and 20 ft)
Warhead: (Walleye I) 374.2-kg (825-lb) HE linear shaped charge, and (Walleye II) 861.8-kg (1,900-lb) HE linear shaped charge

Area Denial Weapons

While battle across the Central Front in Europe remains an unlikely prospect, military planners nevertheless have to respond to a potential threat. Given the current Soviet numerical superiority in conventional terms, NATO has to consider methods of dealing with multiple targets with one shot.

Designed specifically to prevent passage of enemy troops and vehicles, the area-denial weapon usually consists of a dispenser with a number of submunitions in the form of bomblets or mines fitted with one or more type of fuse. These last may be of the delayed-action type, whereby the submunition becomes live only after a preset time period has passed; or of the permanent fuse type, whereby the device is live from the moment of laying and remains so until it is detonated by an external source; or of the self-destruct type, whereby the weapon is live when laid but after a preprogrammed time renders itself somehow inoperative, or more simply explodes.

The US armed forces, using the experience of the Vietnam War as their guideline, were especially gifted in developing munitions of this type. The US Air Force's latest example is the current Gator anti-armour mine system. Designed for laying from high-speed aircraft of all the services for interdiction of second-echelon forces in assembly areas and on the march, the Gator has as submunitions the Honeywell BLU-91/B magnetic influence anti-tank mine and the Aerojet BLU-92/B anti-personnel fragmentation mine. Each mine has three selectable self-destruct times, the chosen period being set on the dispenser before the mission. A total of six Cluster Bomb Units (CBUs) have been identified with the system: the CBU-78/B and CBU-84/B each carry both types of mine, the CBU-82/B and the CBU-85/B carry the BLU-91/B, and the CBU-83/B and CBU-86/B carry the BLU-92/B.

In European circles the British have not had the same inclination to follow this path, but instead have evolved the Hunting Engineering JP233, which will be used with a cratering submunition and an area-denial weapon to prevent repairs to the area damaged by the cratering device.

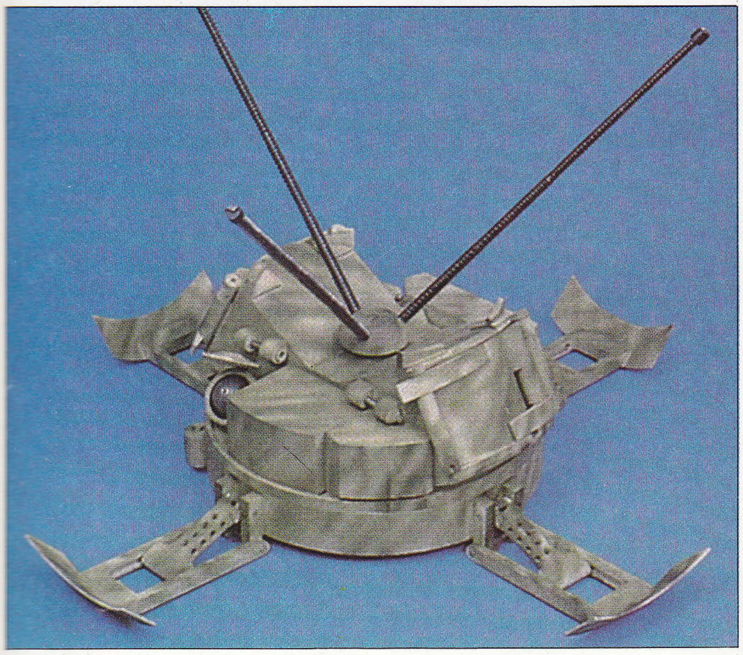
The West Germans have taken this concept further with their MW-1 multi-purpose dispenser, for which they have produced a whole range of predominantly area-denial type submunitions. These are subdivided into two mixes for use against specific classes of targets.

Surprisingly Israel, which has had more combat experience than most against the whole spectrum of targets likely to be encountered during air-to-surface operations in any future war, has not been seen to use area-denial weapons of the types described above. It prefers instead to rely on more conventional iron bombs with simple delay-action fuses and on instantaneous effect CBUs such as the TAL-1 and TAL-2.

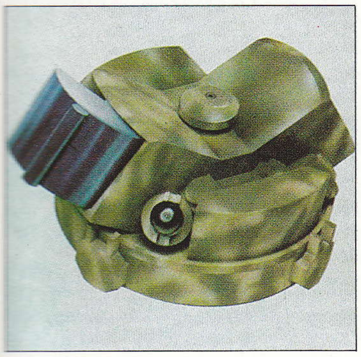
The Soviets have in contrast used a number of area-denial weapons during the Afghanistan war, where for example helicopters and fixed-wing aircraft have dropped canisters that dispense in flight large numbers of small irregularly-shaped plastic PFM-1 minelets filled with sufficient liquid explosive to blow off a person's hand or foot. This is a particularly effective weapon against the *mujahadeen* guerrillas, who have to walk and to use animals to carry their weapons and supplies. In the same category must be placed the persistent chemical agent-filled iron bomb and shell, which significantly restrict or totally prevent movement by unprotected personnel and equipment over any section of terrain contaminated with an agent that is lethal to humans by skin absorption or inhalation. The Soviets have used such bombs in Afghanistan, and the Iraqis have used similar munitions against the Iranians in recent months.

A slightly different situation is covered by the very large mine-dispensing systems used by helicopters. These are typified by the Valsella VS/MD scatter-dropping unit for carriage as an underslung load by medium- or heavy-lift helicopters. This system usually carries a mix of VS-1.6 anti-armour and VS-50 or VS- Mk 2 anti-personnel mines, which are laid as part of a large 'quick' reaction minefield during rapidly changing tactical situations such as an enemy break-through. This particular field is well covered by the Italians, although West Germany and the UK are now exploring the possibilities.

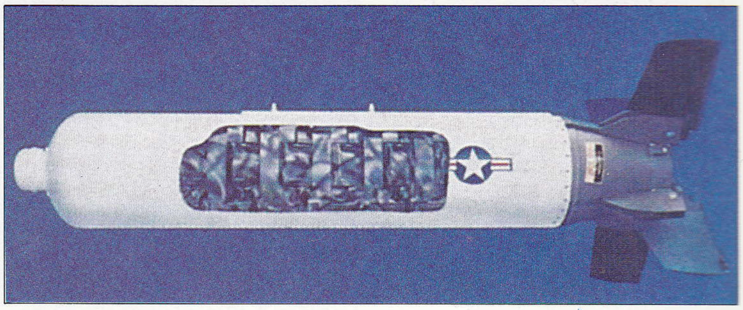
For the future the adaptation of 'smart' submunitions to area-denial technology is obvious, a case in point being the development of the Extended-Range Anti-armour Munition (ERAM) for use in the US Air Force's Tactical Munition Dispenser, the SUU-65/B, to form the CBU-92/B munition. The ERAM is ejected randomly over the target area and floats down on a parachute. Once on the ground, the weapon's three acoustic sensor probes are extended and the two Avco Skeet self-forging fragment (SFF) warheads are armed. When a target is detected, classified and tracked by the probes, the onboard data processor calculates the target's future position and aims the first Skeet launcher towards this point. The Skeet is then launched, engaging the target from above with the SFF warhead; the ERAM has in the meantime swung back to start a sweep for another target.



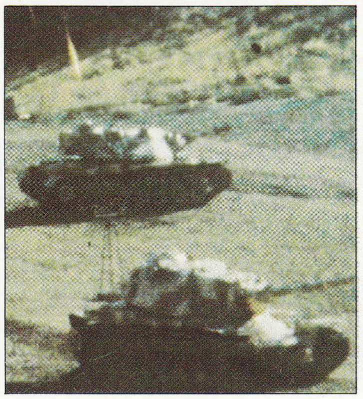
Above: Once on the ground, the ERAM submunition deploys its three acoustic and infra-red sensors. Once an armoured vehicle is in range the mine fires one of its Skeet munitions (like a clay pigeon, hence the name) to explode directly over the target.



Left: ERAM before ground deployment. If the Skeets do not find a target once launched, they do not explode, but fall to the surface where they act as conventional mines. Thus ERAM can be used to attack both tank formations and lines of communication.



Above: An SUU (Suspended Underwing Unit) dispenser shows its load of ERAM submunitions. Each of the nine submunitions carries two Avco Skeet mines, each equipped with infra-red and acoustic sensors. When dropped the canister sheds its mines after deploying a parachute.

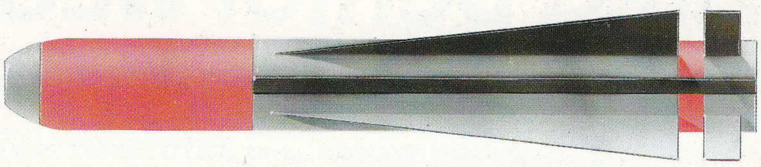


Above: Explosion of an anti-armour submunition after detecting a tank. By launching the weapon high in the air above the tank the explosion can be directed onto the weakest point in the armour of a modern tank, the top.

Above: The force of the exploding shaped charge forms a dart-shaped penetrator out of a disk of copper in the Skeet, which is then projected at very high velocity to the thinner top surface of the target. It can also explode upwards when run over by a tank.

USA

Hughes AGM-65 Maverick



Only 2.49 m (8 ft 2 in) long and weighing from 210 kg (463 lb), Maverick is the smallest fire-and-forget missile in the USAF's tactical inventory. It has been manufactured in a variety of guidance systems, including IR and laser.

Smallest of the fully-guided launch-and-leave ASMs for the US services, the **Hughes AGM-65 Maverick** was originally a US Air Force programme but has now been adopted for both the US Navy and Marine Corps. The basic centroid TV homing version, the **AGM-65A**, entered US Air Force service in January 1972, and at least 30 were fired in combat during that year in Vietnam; another 69 were fired by Israeli pilots against Arab targets during the 1973 Yom Kippur War. Although scoring 87 hits, the missile was found to be severely limited in use because of the low magnification of its TV camera, which forced pilots to close to well within the maximum launch range in poor weather just to see the target clearly enough to achieve a lock-on. To overcome this problem the **AGM-65B** scene-magnification version was next produced. This has the TV image magnified to twice its previous size and made clearer, thus enabling the pilot to identify the target, lock-on the missile and fire it much more quickly and at a greater slant range than that of the AGM-65A.

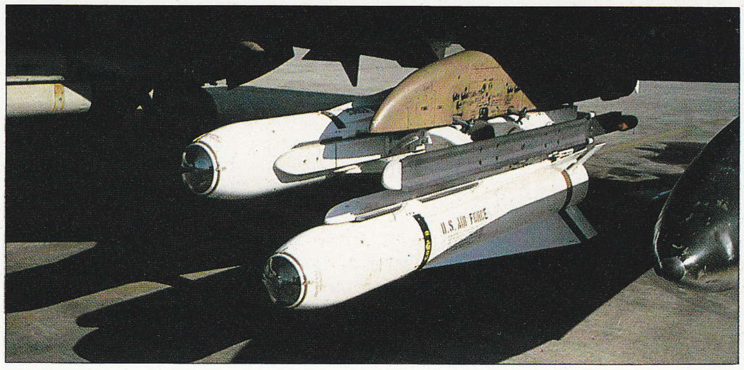
The follow-on version was the **AGM-65C** for the US Marine Corps, which was laser-guided for use in the close-support role against targets designated by ground-based or airborne laser designators. The latter can be any of the Pave Knife, Pave Penny, Pave Spike or Pave Tack systems, or even a compatible non-US designator.

This weapon was superseded in 1982 by the **AGM-65E**, which has a 136-kg (300-lb) penetrating blast fragmentation warhead with a three-position selectable fuse delay.

In May 1977 Hughes began development for the US Air Force of the **AGM-65D** with an imaging IR seeker that enables the Maverick to lock on at a range at least twice the distance otherwise possible in European areas in mist and rain or at night. It will be the standard missile used with the LANTIRN night and adverse-weather detection system now being fitted to USAF General Dynamics F-16 Fighting Falcon fighter and Fairchild A-10 Thunderbolt II attack aircraft.

The US Navy will adopt the **AGM-65F**, which is essentially the same as the AGM-65D but with the warhead and fuse of the AGM-65E and modified guidance software to give maximum effects against surface ships. Weapons of the AGM-65 series are fielded by Egypt, Greece, Iran, Israel, Morocco, Saudi Arabia, Singapore, South Korea, Sweden, Switzerland, Taiwan, Turkey, US Air Force, US Navy, US Marine Corps and West Germany. Others are believed to be negotiating for the type.

Above: The standard Maverick can be locked on to a target by the pilot of the releasing aircraft centring the potential target on the monitor screen in his cockpit. The infra-red version has a similar method of operation, with the added advantage of being effective at night or in bad weather.



Right: Mavericks are loaded onto a Fairchild A-10 while on deployment to Egypt as part of a 'Bright Star' exercise. The missile is in use with the Egyptian air force as well as the air forces of 12 or more countries. Total production of TV Maverick alone is approaching 30,000 missiles.

Specification

AGM-65 Maverick
Type: air-to-surface missile
Dimensions: length 2.489 m (8 ft 2 in); span 0.719 m (2 ft 4.3 in); diameter 0.305 m (12 in)
Launch weight: 210 kg (463 lb) except AGM-65E/F 287.4 kg (633.6 lb)
Propulsion: solid-propellant rocket
Performance: speed subsonic; range between 0.9 and 24.2 km (0.56 and 15 miles); CEP about 1.5 m (5 ft) except AGM-65C/E which is less than this figure
Guidance: (AGM-65A/B) TV imaging, (AGM-65C/E) laser-homing and (AGM-65D/F) imaging IR
Warhead: 56.7-kg (125-lb) HE shaped charge except AGM-65E/F 136.1-kg (300-lb) HE penetrating blast fragmentation

U.S. AIR FORCE

A pair of AGM-65 Mavericks are carried under the wing of a McDonnell Douglas F-4 Phantom, the first aircraft to fire the missile in anger in Vietnam in 1972. Also used in the Yom Kippur war of 1973, the TV Maverick requires good viewing conditions to be most effective.

British Army

Part 2

British reconnaissance regiments are equipped with the Alvis FV101 Scorpion, seen here exercising on Ascension Island. Powered by a military version of the Jaguar 4.2 litre engine, it has good acceleration and can reach 80 km/h (50 mph) on roads.

As with any army, that of the UK is divided into different arms of the service, but the British army retains a regimental system that extends beyond the old infantry and cavalry allocations to all other arms. Very basically a soldier joins the army into a regiment or corps, and then remains with it throughout the main part of his service career. This is particularly true of the cavalry and infantry units and to a lesser degree the technical or other arms. It is possible to transfer from one arm to another (e.g. from the Royal Artillery to the Army Air Corps), and officers can take staff postings as opposed to regimental postings. The 'teeth' arms will be considered first.

The Royal Armoured Corps (RAC)

The Royal Armoured Corps contains many of the old cavalry regiments plus the Royal Tank Regiment and is divided into armoured regiments, equipped with tanks, and armoured reconnaissance regiments, equipped with the Scorpion family of reconnaissance vehicles. The various regiments carry out tours of duty in their specific functions, and the Household Cavalry regiments in addition carry out tours of ceremonial duties interspersed with tours of combat duties. There are also two Territorial Army yeomanry regiments who carry out reconnaissance functions using the Fox reconnaissance vehicle. The RAC also operates the Swingfire long-range anti-tank guided missile.

The Infantry

The infantry regiments make up the main strength of the army, and there are in all 55 infantry battalions. Lumped together as divisions for administrative purposes, these battalions would be joined in emergency by a further 38 infantry battalions from the Territorial Army. The modern infantry battalion is a powerful force containing four (sometimes three) companies each of three platoons and a headquarters platoon. Each battalion has its own fire-support mortar platoon, an anti-tank element and a pioneer engineer platoon. The battalion is also equipped with night-vision equipment, its own signals element, and some battalions have variable weapons increments to suit local requirements. A new mobile anti-tank force equipped with Spartan/Milan is to be formed soon.

Infantry based in BAOR is classed as mechanized infantry and travels in the FV432, scheduled to be supplemented by the MCV-80. Some battalions based in the United Kingdom but scheduled for BAOR in time of war will use the new Saxon wheeled armoured personnel carrier. Infantry battalions based in the United Kingdom and elsewhere are based on the 4-tonne truck. The infantry includes the five battalions of the Brigade of Gurkhas.

The Royal Artillery (RA)

The Royal Regiment of Artillery includes the Honourable Artillery Company, the Royal Horse Artillery and the Royal Artillery. In practice the Royal Horse Artillery (RHA) operates in the same manner as the Royal Artillery, apart from acting as a standard-setter for the rest of the gunners, while the Honourable Artillery Company (HAC) is a Territorial Army unit with ceremonial, social and observation post functions.

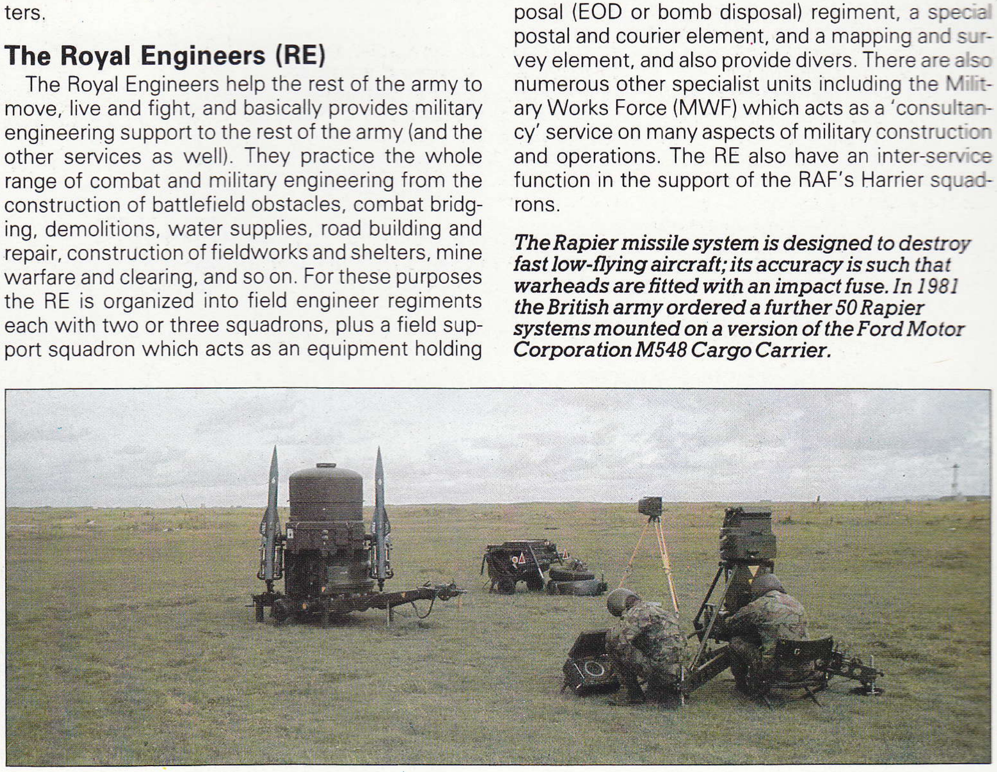
The RA holds and fires the army's only nuclear weapons (Lance missiles and the 203-mm/8-in M110 self-propelled howitzer), both of which operate as part of BAOR. BAOR holds the bulk of the army's artillery strength, most of it self-propelled on tracks (M110, 175-mm/6.89-in M107, 155-mm/6.1-in M109A2 and 105-mm/4.13-in Abbot). Units based in the United Kingdom use either the 155-mm (6.1-in) FH-70 or the 105-mm (4.13-in) Light Gun, both of them towed weapons. Most of the 105-mm (4.13-in) and 155-mm (6.1-in) Field Regiments (regiment is the RA's term for a battalion-sized formation) has three batteries each with eight guns. The RA also has under its control Blowpipe/Javelin air defence missiles and the Towed and Tracked Rapier air-defence units. The RA also has its own locating regiment with surveillance drones, sound ranging and survey elements, and is soon to have its own computer-based command and control system. All batteries already have their own fire-control computers.

The Royal Engineers (RE)

The Royal Engineers help the rest of the army to move, live and fight, and basically provides military engineering support to the rest of the army (and the other services as well). They practice the whole range of combat and military engineering from the construction of battlefield obstacles, combat bridging, demolitions, water supplies, road building and repair, construction of fieldworks and shelters, mine warfare and clearing, and so on. For these purposes the RE is organized into field engineer regiments each with two or three squadrons, plus a field support squadron which acts as an equipment holding unit and also provides support when required. Specialist regiments include an armoured engineer regiment equipped with specialized armoured combat engineer vehicles and mobile bridges (the Centurion AVRE and the Chieftain AVLB), and an amphibious engineer regiment equipped with the M2 mobile bridge/ferry.

The RE also contain an explosive ordnance disposal (EOD or bomb disposal) regiment, a special postal and courier element, and a mapping and survey element, and also provide divers. There are also numerous other specialist units including the Military Works Force (MWF) which acts as a 'consultancy' service on many aspects of military construction and operations. The RE also have an inter-service function in the support of the RAF's Harrier squadrons.

The Rapier missile system is designed to destroy fast low-flying aircraft; its accuracy is such that warheads are fitted with an impact fuse. In 1981 the British army ordered a further 50 Rapier systems mounted on a version of the Ford Motor Corporation M548 Cargo Carrier.



12 PASS

British infantry sections are equipped with an L7 General Purpose Machine Gun, the British version of the Belgian Mitrailleuse d'Appui Général. The GPMG is also mounted on a tripod for sustained fire, using standard NATO 7.62 mm×51 ammunition; its cyclic rate of fire is 750-1000 rpm.

The Royal Signals

The role of the Royal Signals is to provide and maintain rapid, accurate and reliable communications for the army. Most units in the army are responsible for their own local communications, but the Royal Signals provide the large networks for higher command echelons and for long-distance communications. This service is provided in BAOR using signal regiments, some of which are at corps level with others at division level. At present the signal network is known as BRUIN, but this is now in the process of being replaced by the advanced PTARMIGAN system. The Royal Signals also provide long-range links with the United Kingdom and many overseas locations using artificial satellites, and also assist in the operation of communications within NATO.

The Royal Electrical and Mechanical Engineers (REME)

The REME act as the army's main repair and maintenance element to keep the army's wide range of equipment fit and ready for use. It thus has to be ready to repair anything from tanks and trucks to medical equipment and cameras. The REME's fitters and mechanics are integrated into almost every unit of the army from the infantry to the gunners, and may operate as part of a unit or as a mobile or static workshop associated with the unit. Many of the trades and skills used by REME are unique within the army.

The Royal Corps of Transport (RCT)

The role of the Royal Corps of Transport is much more than driving trucks, which is only one facet of the corps' activities. The corps also acts as the army's movements organizers and also gets involved in the operation of port, air movements and the provision of air logistic support. The driving tasks are mainly carried out by the RCT's Transport Regiment, which acts as the army's main load-carrier. The RCT also provides the army's ambulance carriers and contains the army's railway specialists, from drivers to railway operators. The RCT also has its own 'naval' arm with a specialist Maritime Regiment operating landing craft, logistics carriers and even a special ammunition-carrying ship. There are also some smaller craft under RCT control.

The Royal Army Ordnance Corps (RAOC)

The RAOC may be regarded as the army's storekeepers, but its operational role is much more than that of supplying stores from static locations. The RAOC moves wth the army wherever it travels or operates, and keeps the supplies of every conceivable item any unit might want, not only ready to hand but also in an operational condition. Many RAOC units are fully mobile and operate from trucks. The RAOC is also responsible for the supply of petrol, fuel and oils to the army, especially in BAOR where a supply pipe network has been established. Other RAOC responsibilities include the large-scale provision of some food (including bread from field bakeries) and the storage, maintenance and repair of all types of ammunition. The RAOC is also involved in the clearing of terrorist-type bomb and other devices in Northern Ireland and elsewhere.

The Medical Services

The army's medical services include the Royal Army Medical Corps (RAMC), the Royal Army Dental Corps (RADC) and Queen Alexandra's Royal Army Nursing Corps (QARANC). These units operate mainly from military hospitals or local garrison medical centres, but in time of war many of the personnel would move out to mobile field hospitals or to the various forward ambulance units.

The Special Air Service (SAS)

The SAS has had rather more public exposure in recent years than it would like, for normally it is a very specialized force used for much of the army's undercover work which would range from operating behind enemy lines to the surveillance and infiltration of terrorist groups. It requires a high level of physical and mental ability from its members, and tends to operate along its own particular lines. The SAS does not recruit from the general public.

The Intelligence Corps

Often known as the 'I Corps', this corps has two main functions: combat intelligence and security. Neither is easy to describe in a few words but basically combat intelligence is the provision of as much background information as possible of an enemy's equipment, methods and operating methods. Security refers to security within the army in the form of denying an enemy access to the army's premises and information.

The Royal Pioneer Corps

The Royal Pioneers Corps has now largely lost its old pick-and-shovel image as it now acts as the army's large-scale materials handling operatives in both stores and forward areas, and its officers also act as the army's management experts when dealing with civil operatives working within the army, e.g. on construction projects. The Pioneers also supply the army's dog handlers for guard duties but on occasion they can still act as the army's main large-scale labour force in support of other arms.

The Royal Military Police

The 'Red Caps' have largely lost their old unloved image as they now act mainly as the army's internal police force concerned with the day-to-day policing of all facets of military life. The MPs pride themselves in that they act as examples for other soldiers to follow, and their role in war would involve traffic control and the control of prisoners-of-war.

Other arms of the army include the Royal Army Education Corps, the Army Physical Training Corps, the Army Catering Corps, the Royal Army Chaplains' Department, the Gibraltar Regiment, the Royal Army Pay Corps and the Women's Royal Army Corps.

On the modern battlefield camouflage is of vital importance, but foliage and face paint are of little value when charging over open ground. This section is armed with the L1A1 Self-Loading Rifle, the British single-shot version of the Belgian FN Fusil Automatique Léger.